

Sacramento-San Joaquin Delta Historical Ecology Investigation

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Delta Stewardship Council

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San Francisco Estuary Institute

Aquatic Science Center

- SFEI formed in 1993
- Towards a **comprehensive, coordinated Regional Monitoring and Research Strategy** to assess the chemical, physical and biological health of the Estuary
- BOD represents agencies, NGOs, industry
- 50 staff
- Administers a **Joint Powers Authority** of the state: the Aquatic Science Center (ASC)
- → *Impartial environmental science synthesis for the region*



Programs

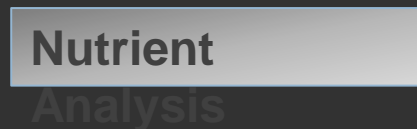
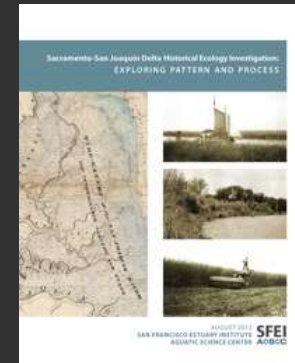
Clean Water



EDIT (Environmental Data, Information, and Technology)



Resilient Landscapes



Talk outline

- What is historical ecology and why is it useful?
- How do we do historical ecology?
- Findings of the *Delta Historical Ecology Investigation*
- How is this information being used?

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"'Coequal goals' means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." (CA Water Code §85054)

*"'Coequal goals' means the two goals of providing a more reliable water supply for California and **protecting, restoring, and enhancing the Delta ecosystem**. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." (CA Water Code §85054)*

“Ecosystem restoration cannot restore the historical Delta.”

Final Draft Delta Plan (page 143)

yet...

“...restoration seeks to return areas to a close approximation of their natural potential, including reestablishing natural habitat and ecosystem functions, as feasible...”

Final Draft Delta Plan (page 145)

Similar in BDCP, ERP, PPIC

“... the first step in a river restoration program should be to develop a solid understanding of what the targeted rivers were actually like before the changes that restorationists seek to undo or mitigate.”

Montgomery 2008 (*Science* 319: 292)

The purpose of historical ecology:

not just to understand *the way things were*

but to understand *the way things work.*

(after Safford 2012)

→ *Both opportunities **and** constraints*

→ *Practical, efficient approaches*

- “Extensive **wide bands or large patches** of interconnected valley/foothill riparian forests...”
- “Produce **sinuous, high-density**, dendritic networks of tidal channels through tidal areas...”
- “Restore and sustain **a diversity of marsh vegetation** ...”

-- Bay Delta Conservation Plan draft

*“Restore **large areas** of **interconnected habitats** within the Delta and its watershed by 2100”*

- Water Code section 85302

*“Restoration of the health of the Delta’s ecological systems by addressing **ecological functions and processes at a broad landscape scale**”*

- Bay Delta Conservation Plan draft

*“Management plans and decisions need to be informed by a **landscape perspective** that recognized interrelationships among patterns of land and water use, patch size, location and connectivity, and species success.”*

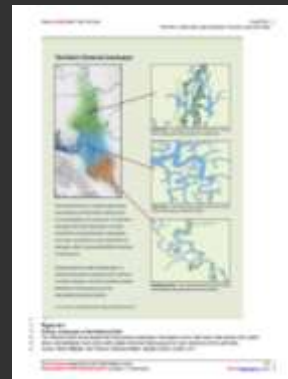
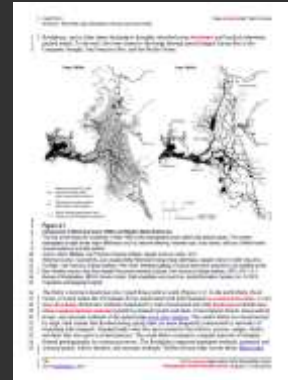
- Delta Plan draft

- How large is large?
- What should be connected to what?
- What is the whole that the parts add up to?
- And how does that look in different parts of the Delta?

→ a landscape vision

Delta historical ecology already being applied

- Advance thinking among scientists and managers towards specific goals and objective
- Incorporated into BDCP, ERP, and Delta Plan drafts
- McCormick-Williamson tract restoration planning
- Cache Slough complex restoration planning
- Delta Landscapes Project: translating historical ecology into landscape-scale restoration tools



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Historical ecology process

Collection



Compilation



Synthesis



Interpretation and Analysis



Reporting





1800

Archaeology reports, tribal Representatives

Explorer journals

1850

Travelogues/memoirs

Diseños, court testimony

1900

Maps and surveys

Landscape photos and art

1950

Aerial photography

Interviews

2000

Scholarly & professional reports & records

Raw
Data



Collected
Data



Compiled
Data

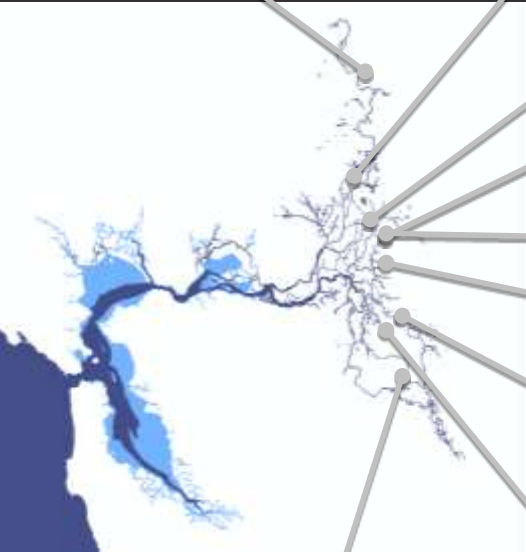
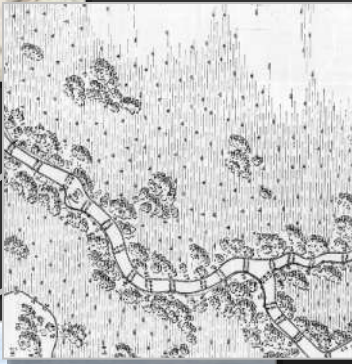
1800

"The lake was situated far out in an impenetrable tulle swamp of immense extent...it was a sort of "sanctuary" to which birds came..."

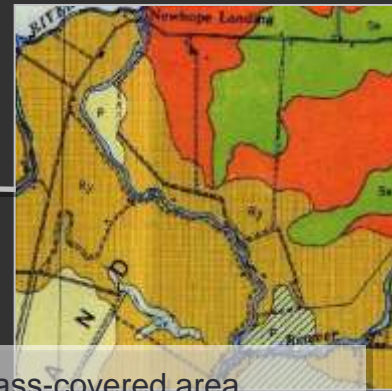


1850

"lagoons...whose waters flowed back swiftly into the Sacramento with the ebbing tides"



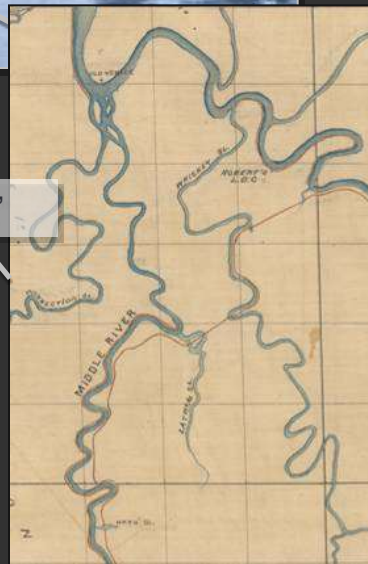
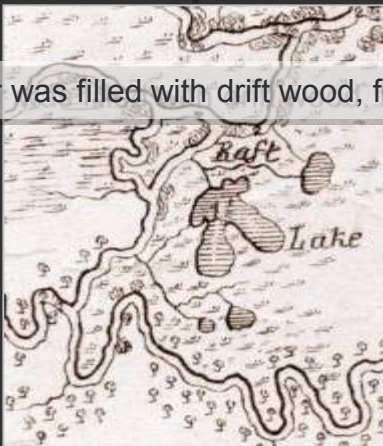
1900



"In a grass-covered area between the forest and swamp"

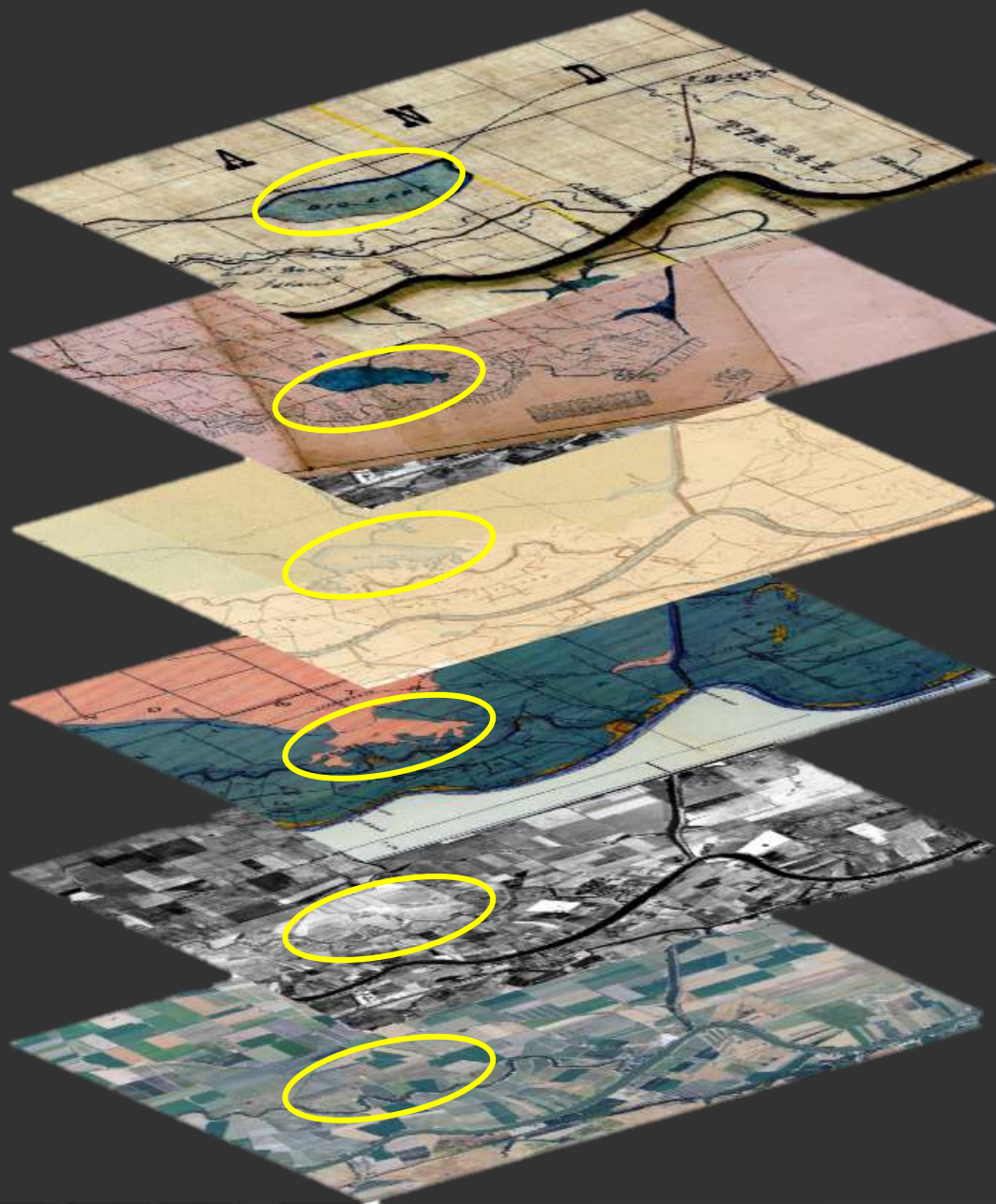
1950

"the river was filled with drift wood, forming a raft"



"nothing but tule, without a tree under which the navigator may find shade"

2000



ca. 1880

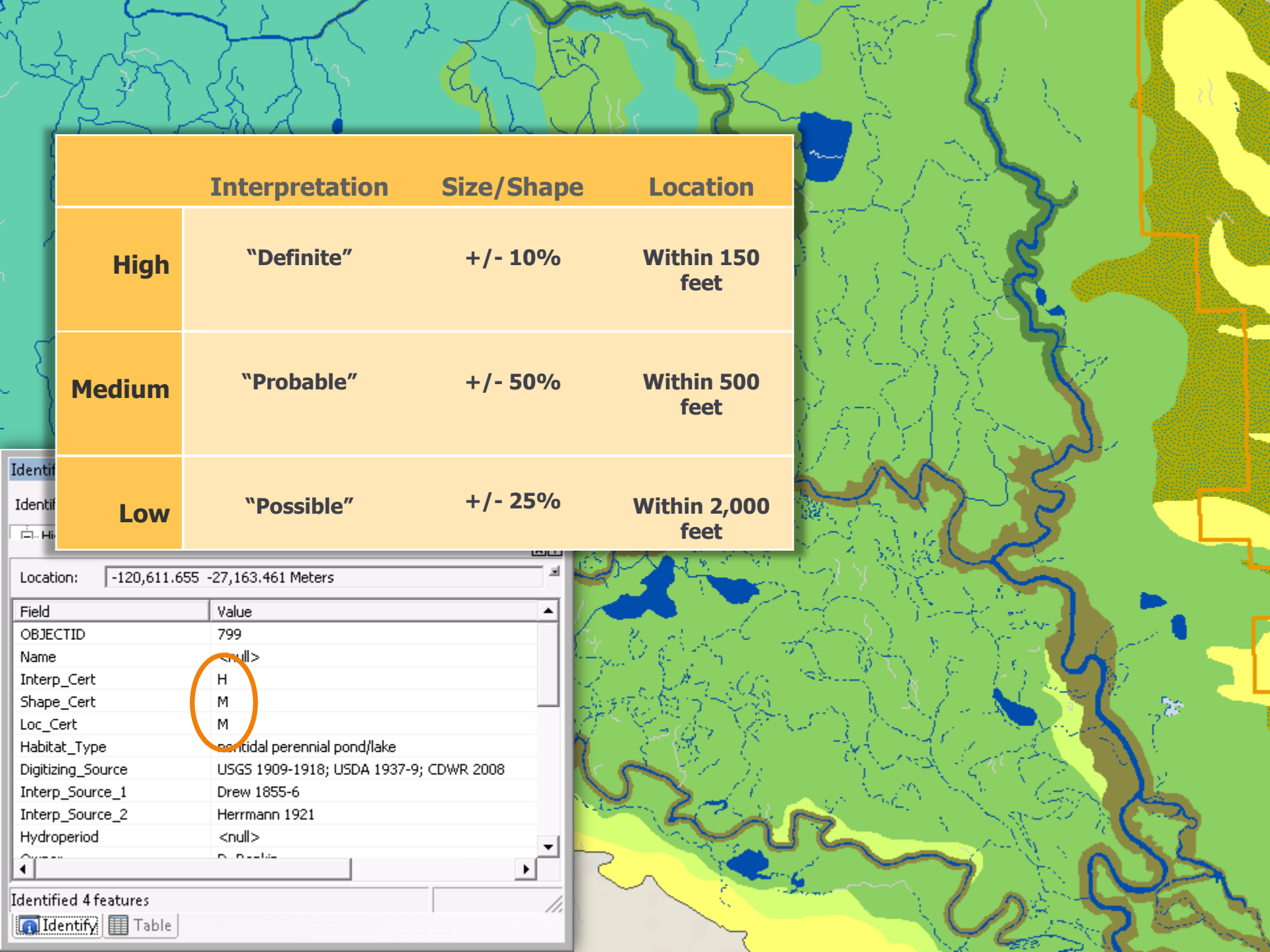
1914

1909-1918

1930

1937

2005



	Interpretation	Size/Shape	Location
High	"Definite"	+/- 10%	Within 150 feet
Medium	"Probable"	+/- 50%	Within 500 feet
Low	"Possible"	+/- 25%	Within 2,000 feet

Identify

Identify

Location: -120,611.655 -27,163.461 Meters

Field	Value
OBJECTID	799
Name	<null>
Interp_Cert	H
Shape_Cert	M
Loc_Cert	M
Habitat_Type	perennial pond/lake
Digitizing_Source	USGS 1909-1918; USDA 1937-9; CDWR 2008
Interp_Source_1	Drew 1855-6
Interp_Source_2	Herrmann 1921
Hydroperiod	<null>
...	...

Identified 4 features

Identify Table

Sacramento-San Joaquin Delta Historical Ecology Investigation:
EXPLORING PATTERN AND PROCESS

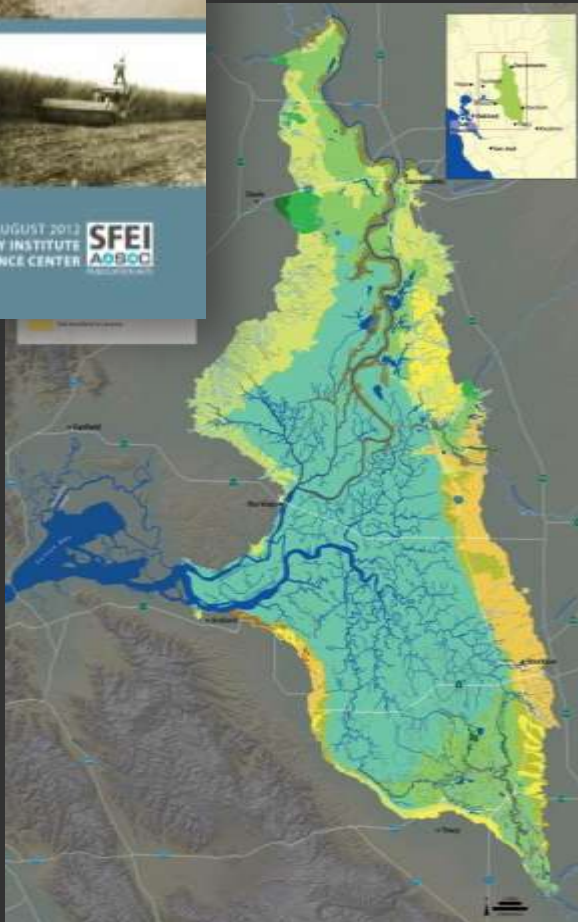


AUGUST 2012
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AQUATIC SCIENCE CENTER



Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process

- Funded by Ecosystem Restoration Program (CDFG, NOAA, US FWS)
- Final Report/GIS Available: www.sfei.org/DeltaHEStudy
- Collaboration with KQED QUEST and Stanford's Bill Lane Center for the American West: science.kqed.org/quest/delta-map/



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- What is historical ecology and why is it useful?
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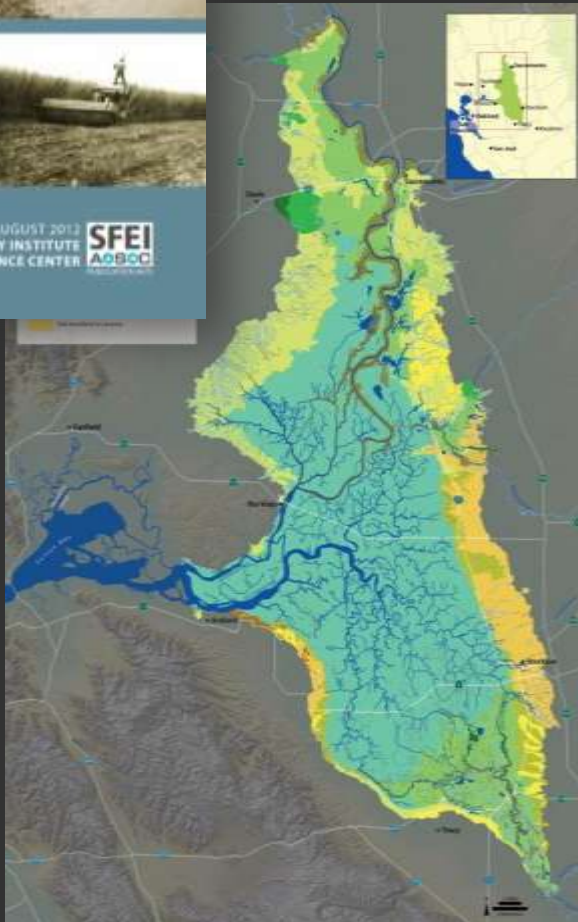


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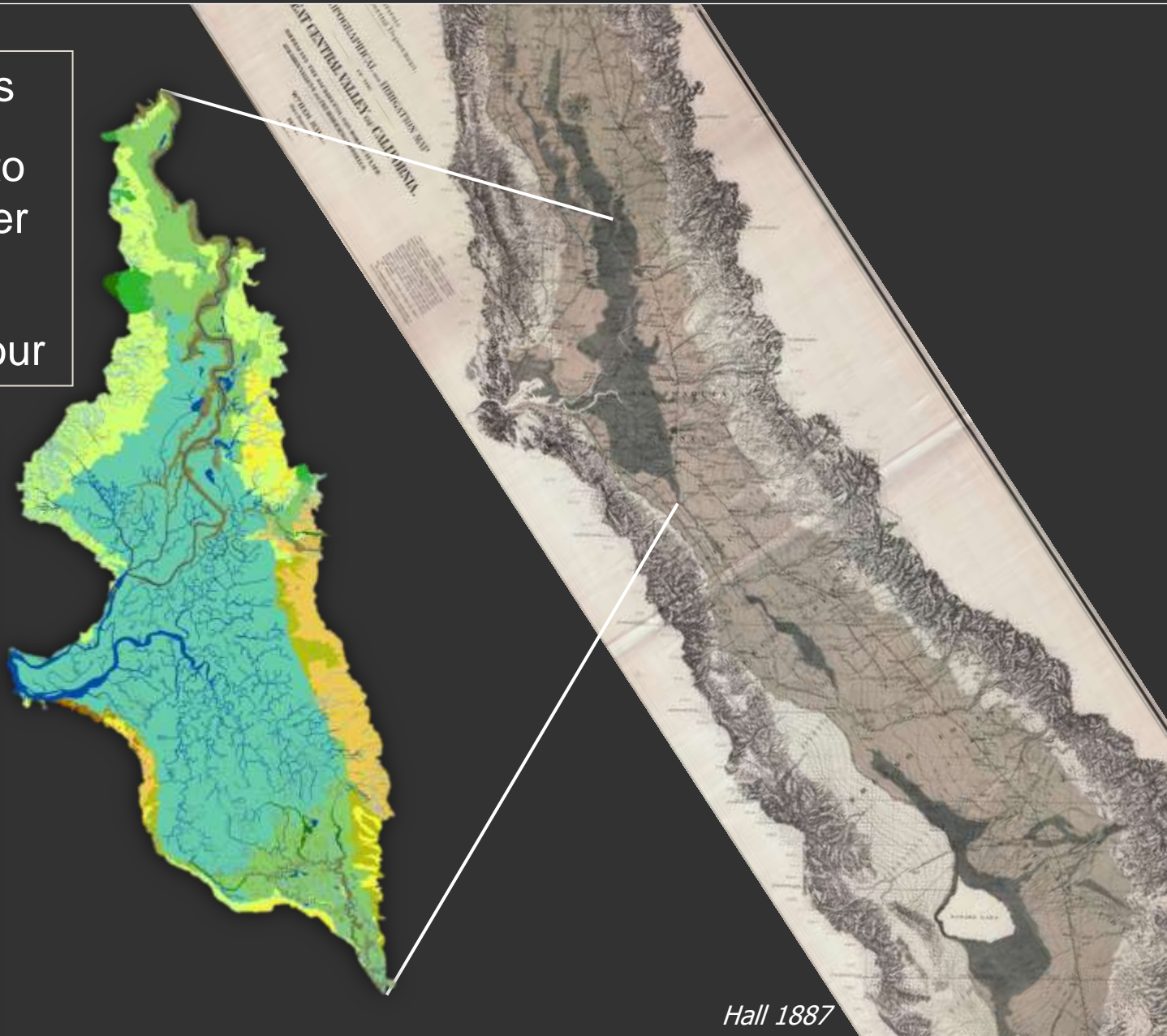
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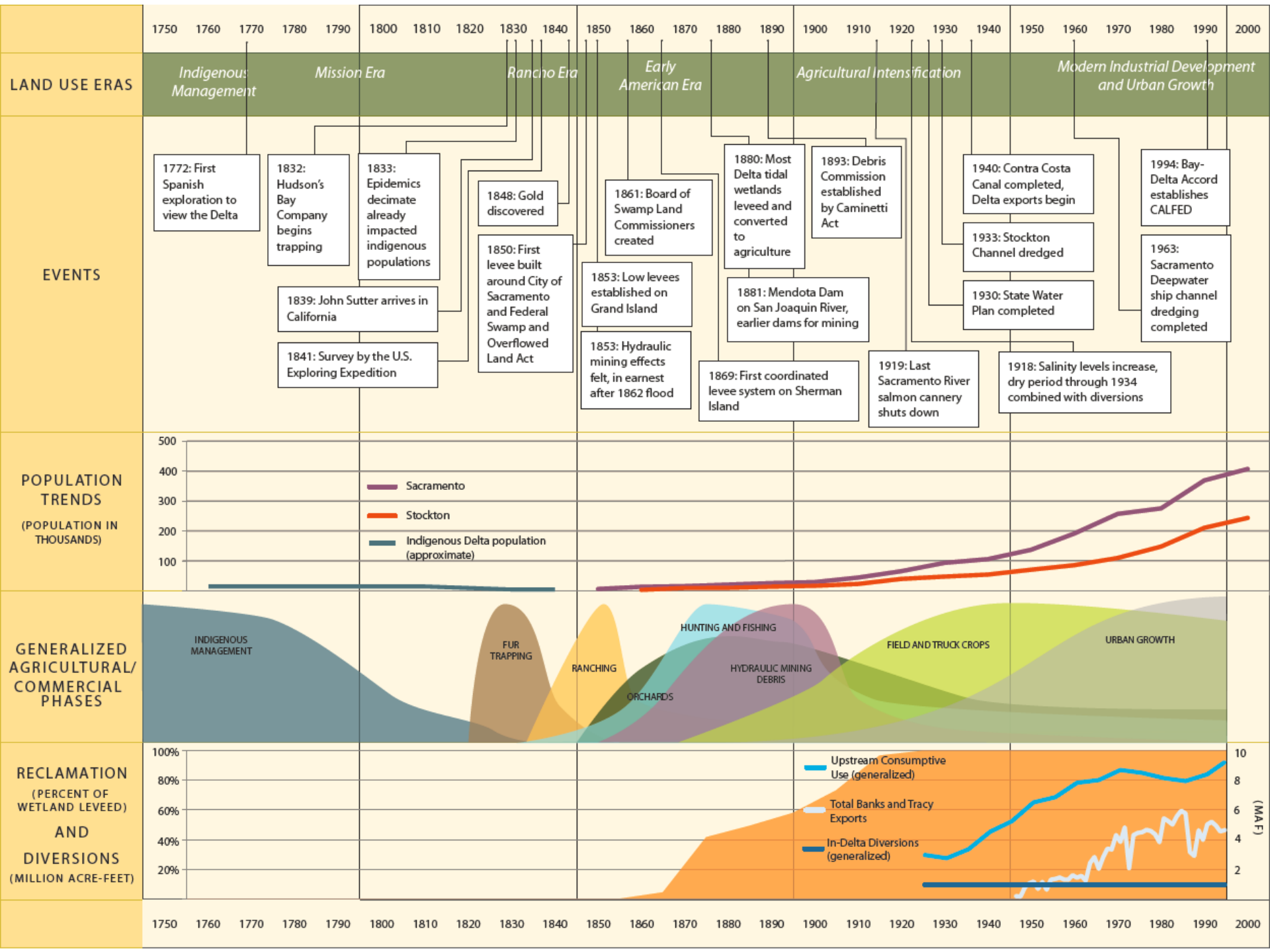


Delta historical ecology study area

- ~800,000 acres
- Feather River to Stanislaus River
- Within 25-foot elevation contour



Hall 1887



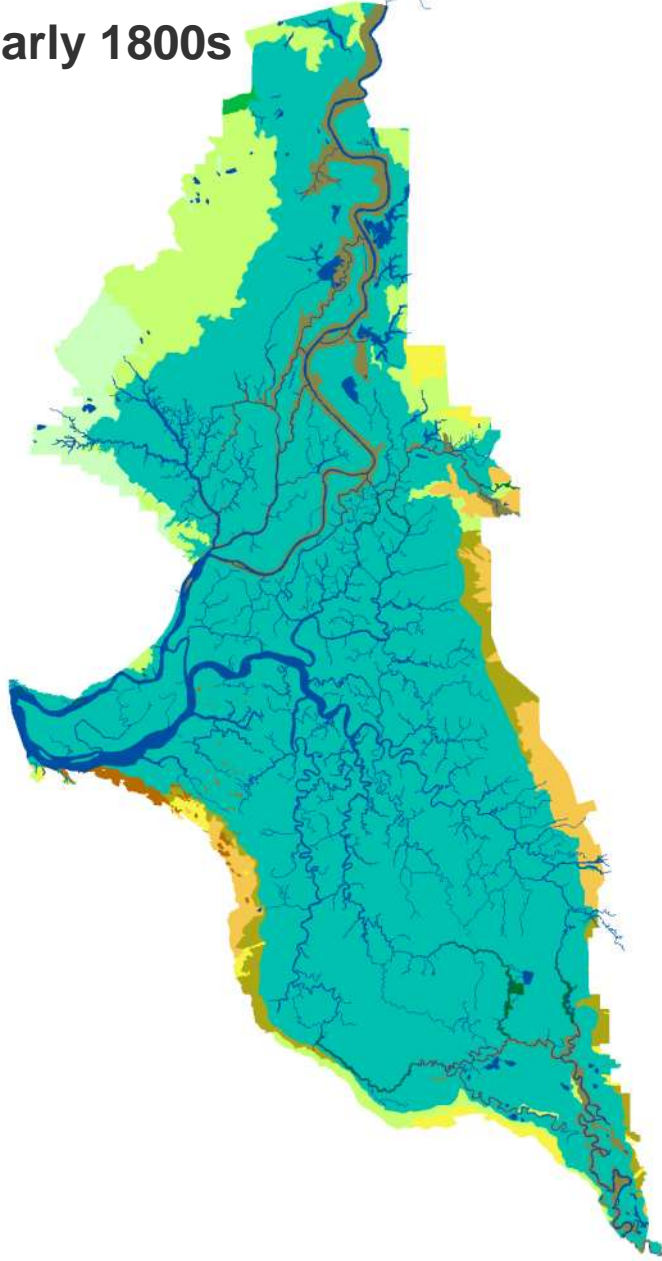
Findings: historical mapping



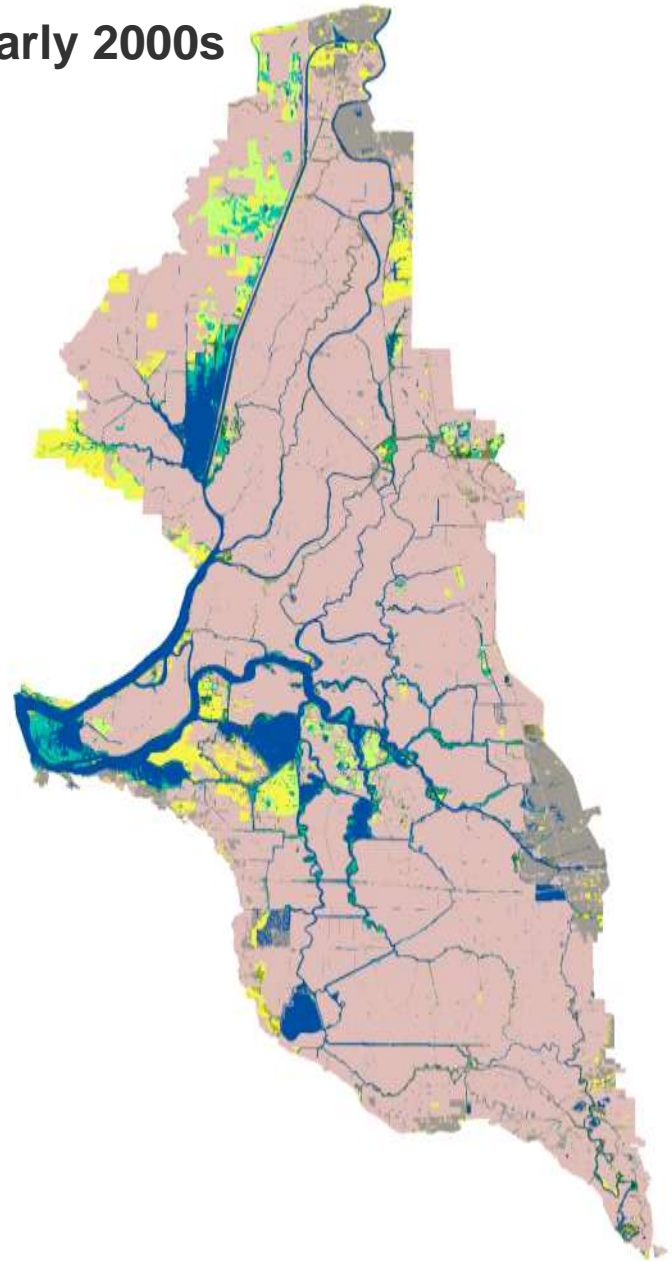
- Relative wetness
 - Tidal = 395,000 acres (50%)
 - Wet year-round = 124,000 acres (16%)
 - Seasonal wetlands = 144,000 acres (18%)
- Tidal channels
 - 1,600 miles, >26,700 acres
 - Small tidal channels were 73% of total length
- Lakes and ponds
 - 83 individual features (>5 acres) within the wetlands equaling >5,700 acres
- Freshwater wetlands
 - 365,000 acres tidal, 113,000 acres non-tidal
- Riparian forest and willow
 - 42,600 acres of forest, 8,800 of willow thickets
- Seasonal wetlands
 - 143,000 acres of wet meadow, vernal pool, and alkali wetland

Land cover change

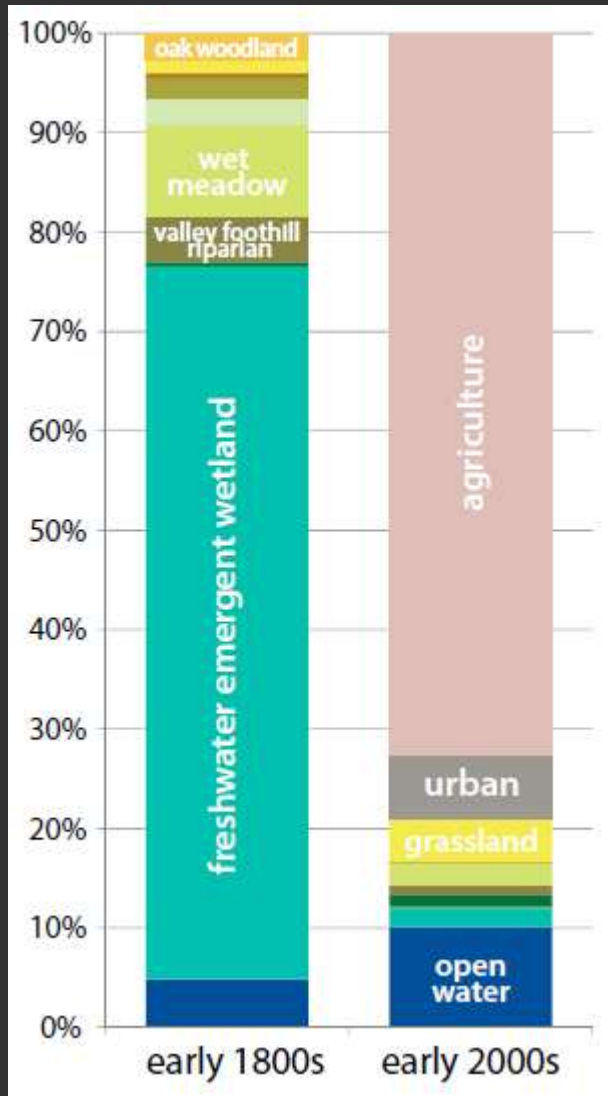
Early 1800s



Early 2000s



Land cover change



- 3% of historical freshwater wetlands remain
- Ratio of open water to freshwater wetland
 - Historically: 7:100
 - Today: 556:100
- Open water now in central Delta instead of as lakes within wetlands upstream
- 81% loss of small tidal channels
- Few true “remnants”
- Highly fragmented natural habitats

Landscape pattern and process

Figure 4.54. Sand mounds above the wetland plain. The map (A) shows the plan view of sand mounds larger than five acres in size that were elevated above tidal ranges. These features, which are white when sand dunes, were historically unique upland features within the context of the surrounding tidal wetland. These features were mapped from various sources, including early 1900s USGS topographic maps, survey maps, 1937 aerial photography, and USGS T-sheets (Davidson 1987). A conceptual profile is shown in B, adapted from Atwater and Balkeup (1998).

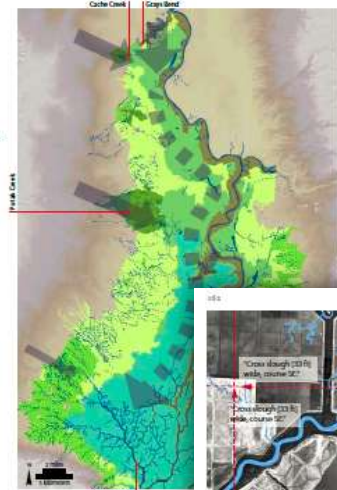
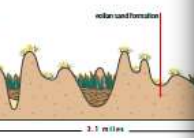
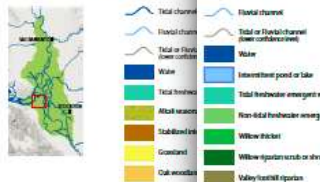
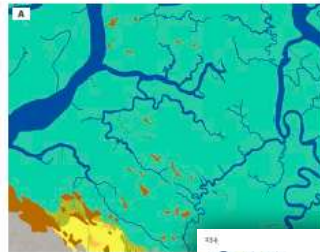


Figure 5.18. The pattern of flood flows in the Delta. Blue arrows indicate direct inputs from river and near Gray's Bend, Putah Creek. The dashed blue arrow from north to south that moved as a band about the mouth of Cache Slough.

Refuge (ADNWR) as well as what was once a prominent 2,800 acre (1,133 ha) expanse of densely vegetated scrub surrounded by more sparsely vegetated areas with oaks in the vicinity of Oakley (most of which is outside the study area; Wackensieder 1875, Carpenter and Coby 1939, Stanford et al. 2011). The Antioch Dunes to the west were historically over 100 feet (30.5 m) in height (Davidson 1887).

The rich Pleistocene dune soils of the sand mounds and western edge had stabilized and developed soil profiles that supported live oaks (*Quercus agrifolia*), forbs, and grasses (Wackensieder 1875, Davidson 1887, Carpenter and Coby 1939, USDA 1977, Stanford et al. 2011). Historical surveys, including early maps, Los Medanos land grant testimony, CLO surveys, and oblique photography, indicate that oaks were associated with these areas (Smith 1866, Wackensieder 1875, Tunell ca. 1925). An 1887 USGS T-sheet (Davidson) shows tree symbols along the backside of the Antioch Dunes (Fig. 4.55a). Witnesses in the Medanos land case testified

water in the tules on January 4 along his survey line in the middle of the McCormack-Williamson Tract, which became deeper southward.

Inundation could also occur in the early summer. On June 13, 1833, trapper John Work passed near the Mokelumne River (Maloney and Work 1943). He wrote in his diary that "the river had overflowed its banks so that we cannot encamp on them nor indeed except in some places approach the river. The lake where we encamped yesterday continues on to the river." He also noted the differences in water temperature, complaining that the shallow water within the flooded basin he was traveling along was "very warm and we cannot get to the river where it might be a little colder" (Maloney and Work 1943).

The many small watersheds entering the valley from the Coast Ranges and eastern foothills were an important annual source of water. These streams spread into distributaries across their alluvial fans, discharging all of their flow into the basins. A general account describes that the streams "lose themselves in the valley [sic] and spreading in all directions form extensive lakes of water" (Clyman and Camp 1928[1848]). though dry in the summer (USDA 1874, USGS 1909-1918, Moerenhout [1849] 1935), these small



Figure 5.19. Periods of overflow. This graphic shows the months in selected years from 1830 and 1840 when the Mokelumne River was overflown. This information was summarized from recollections of Josiah S. Greene, who testified before the Swamp Land Commission in 1892 (see the Appendix).



Figure 4.31. The frequency and size of flooded tidal channels branching from Disappointment Slough are found in a new CLO survey that extends within the wetland margins. It should be noted that this survey was conducted in 1878, during a period of extensive levee construction in the Delta. Though records indicate that these tracts of land were not officially reclaimed until the early 1900s, it is likely that some activity was already underway at the time of this survey. (Benson 1878-Q, USDA 1917-1939)

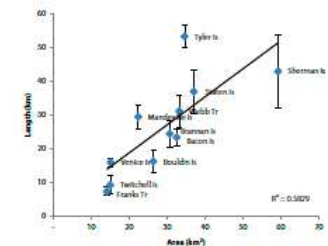
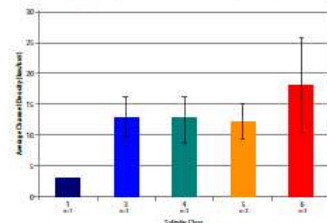


Figure 4.32. Relationship between island area and mapped channel length. Mapped historical island tidal channels were summed for each of the major central Delta islands. Those that were bounded by substantial natural levees for the majority of their perimeter (such as Borden, Tyler, and Central Island) were excluded. Inner levees are derived from the miles of channel mapped that are of "moderate" or "low" interpretation certainty; that is, those channels that do not have many lines of evidence supporting them.

Figure 4.22. Channel density by salinity class. The freshwater salinity class has significantly lower density than the other classes. There are relatively similar densities across the middle salinity classes. (reprinted with permission from Collins and Goetsch 2006)



tolerances of marsh vegetation (in freshwater conditions, tule is able to grow at elevations below MLLW and would therefore occupy small and shallow channels; Atwater et al. 1979).

A complicating factor for estimating channel density is the uncertainty associated with the level of detail shown in Delta mapping sources. Unlike the San Francisco Bay, there is no single comprehensive and detailed data source for historical networks comparable to the U.S. Coast Survey (USCS) T-sheets. To calibrate the level of detail in the mapping from this study with the level of detail found in other sources, we made several comparisons to what similar sources showed in the San Francisco Bay. We compared USGS 7.5-minute topographic maps against USCS T-sheets in Suisun Bay and found that the T-sheets usually mapped one channel order more than the topographic maps (i.e., a 3rd order T-sheet channel was shown as a 2nd or 1st order USGS channel). Since most mapping sources we used were closer to USGS scales, one conclusion could be that the mapping does not show the lowest order channels. However, by comparing historical channel density as shown by USGS maps of similar vintages in the Truckee-Napa River marshlands (Crossting 2012) and remnant Delta marshes, we found consistently lower densities in the Delta, which supports the conclusion that channel densities were, in fact, lower in the Delta historically than in more brackish and saline marshes downstream.

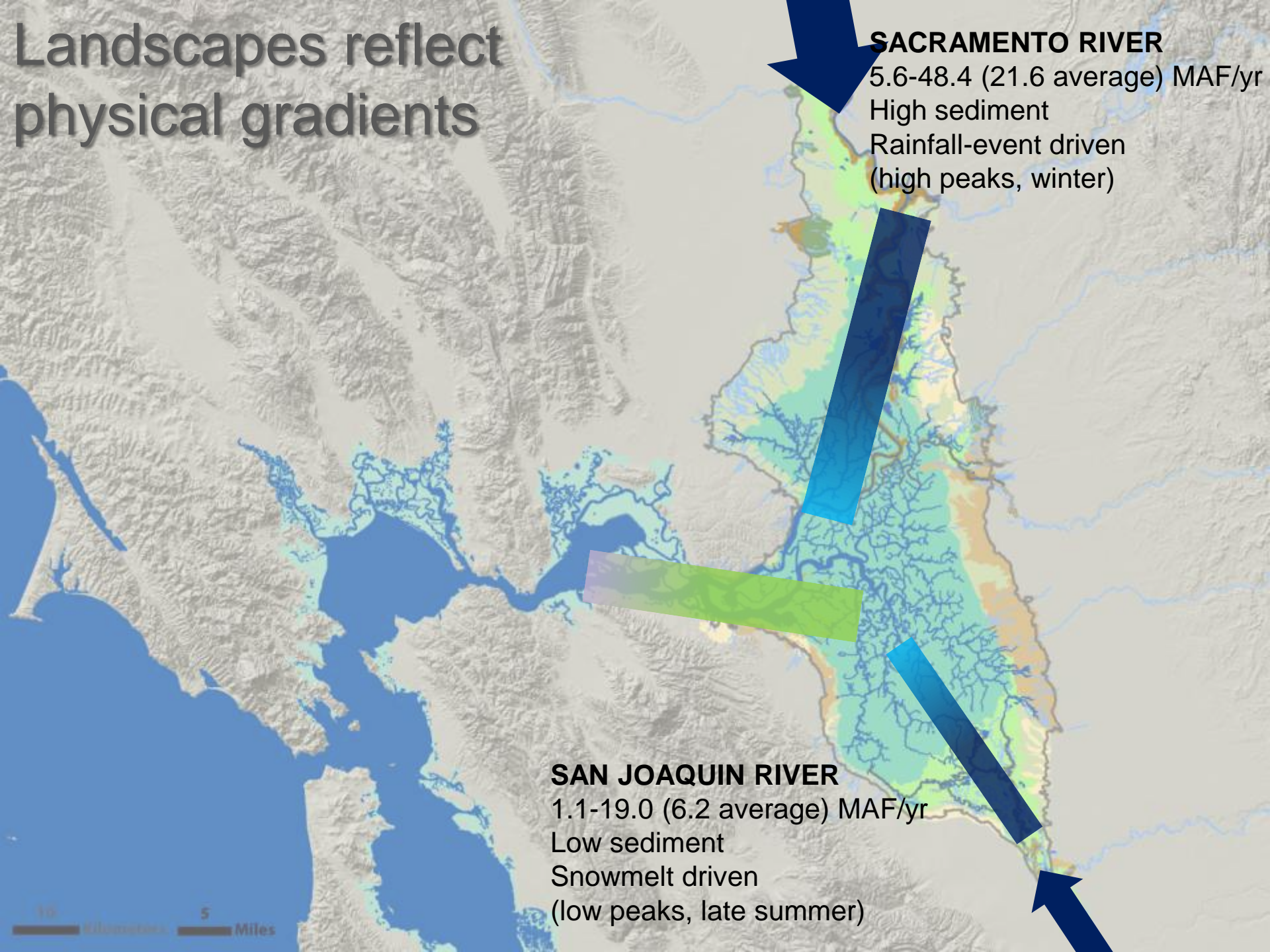
To further evaluate this relationship using other data, we compared early aerial photography of wetlands in the Delta, Napa, and Alameda at the same scale using imagery from other historical ecology studies (Crossting 2012, Stanford et al. forthcoming). Signatures of dense networks of narrow sloughs are visible in the reclaimed Napa and Alameda marshes, while fewer comparatively wide and less sinuous channel signatures are seen in

Key points

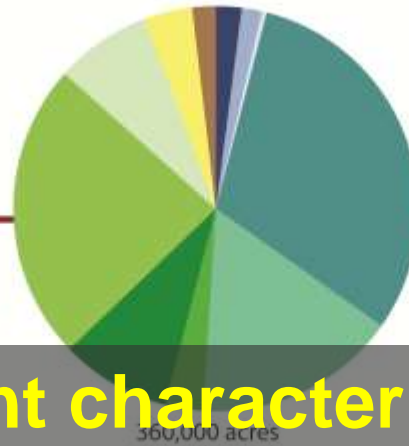
- Multiple landscapes
 - Habitat mosaics arranged in distinct patterns
 - Expressed across broad physical gradients



Landscapes reflect physical gradients



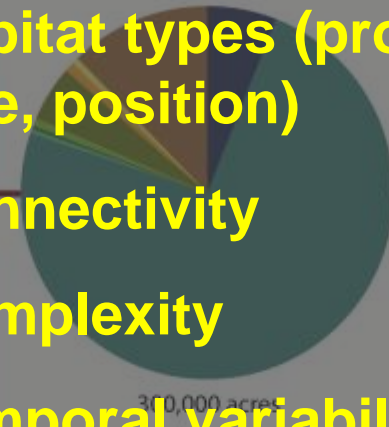
Conceptual models of historical landscapes



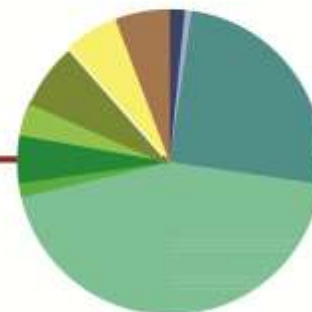
North Delta: flood basins

Different characteristics

- Habitat types (proportion, size, position)
- Connectivity
- Complexity
- Temporal variability



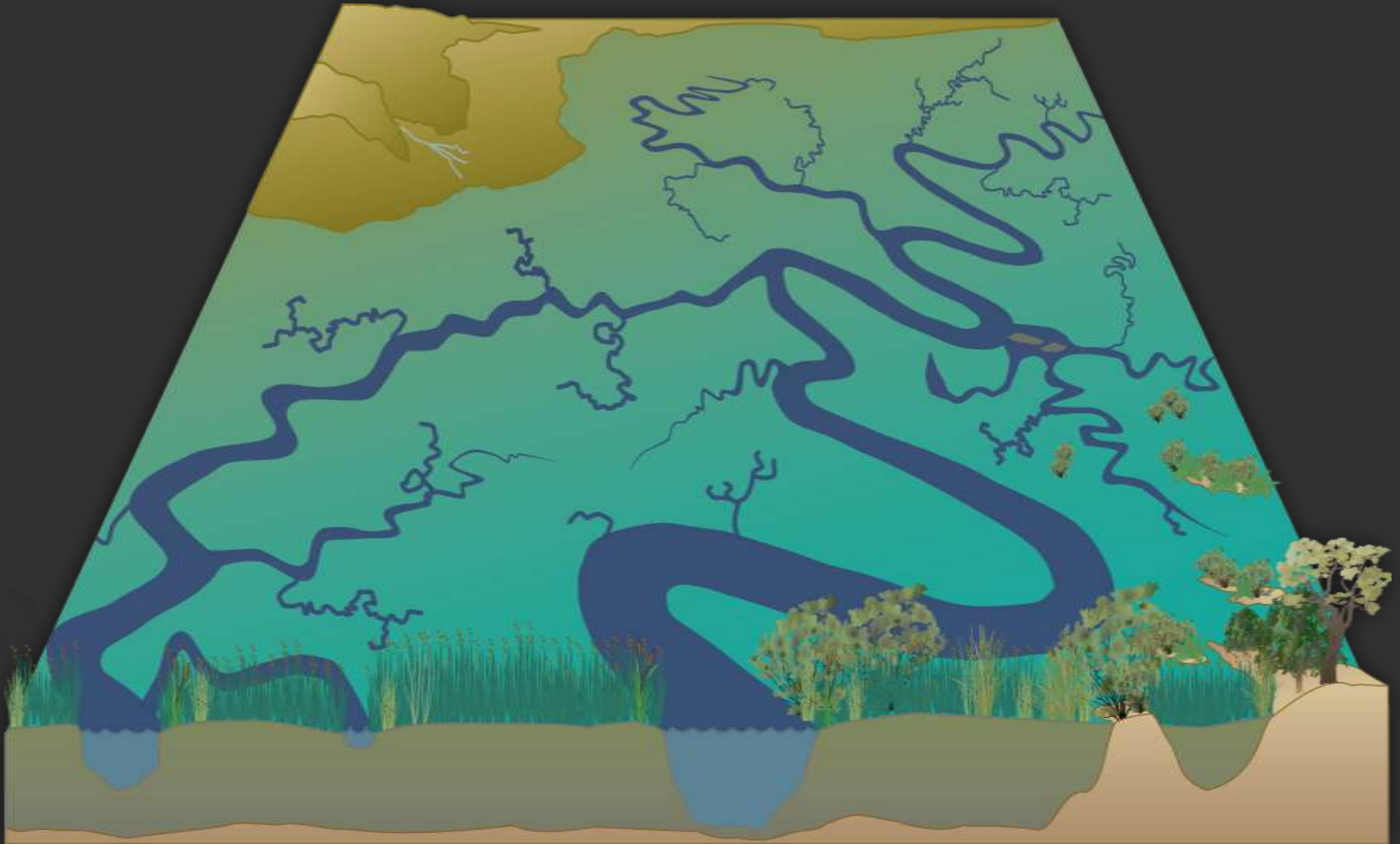
Central Delta: tidal islands



South Delta: distributary rivers

- waterway
- pond/lake
- seasonal pond/lake
- tidal freshwater emergent wetland
- nontidal freshwater emergent wetland
- willow
- valley foothill riparian
- wet meadow/seasonal wetland
- vernal pool complex
- alkali seasonal wetland complex
- inland dune scrub
- grassland
- woodland/savanna

Central Delta: where tides dominate

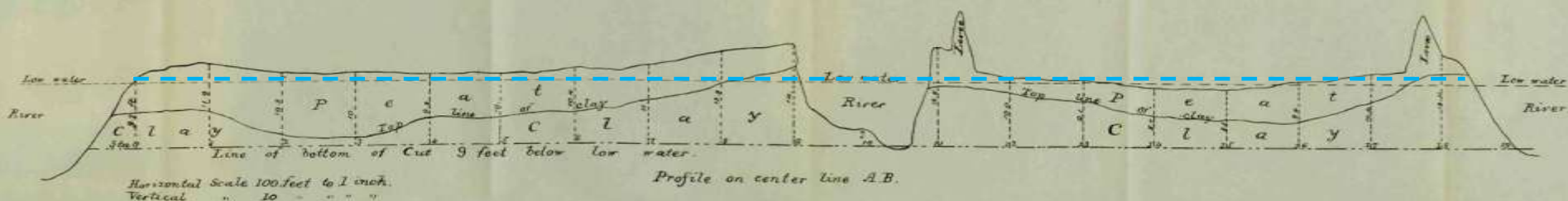


Central Delta: where tides dominate

- Low banks
- Frequent tidal inundation
- High connectivity between land and water

"The water reached our blankets at the turn of the tide"

- October 1811, Abella and Cook 1960



Central Delta: where tides dominate

- Numerous sinuous tidal channels of different sizes

*“The **number and intricacy** of the winding sloughs and channels that traverse this...low marshy land is worthy of notice.”*

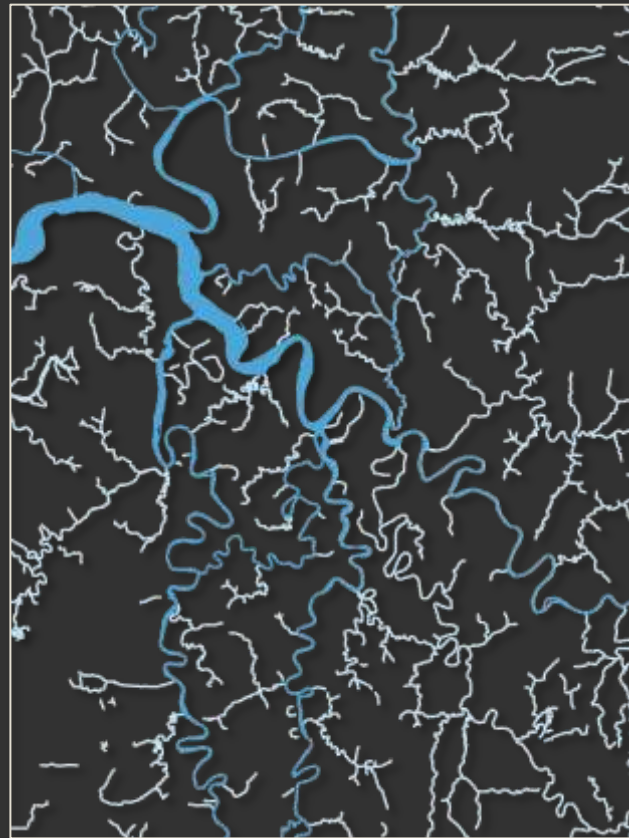
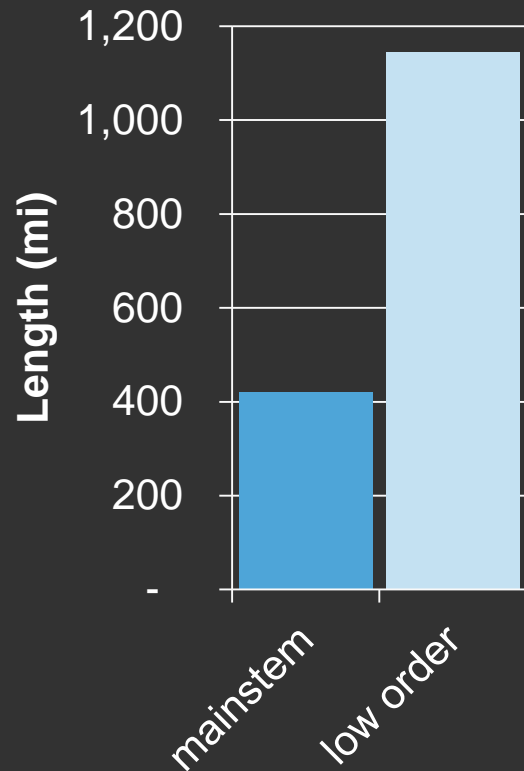
- US War Department 1853

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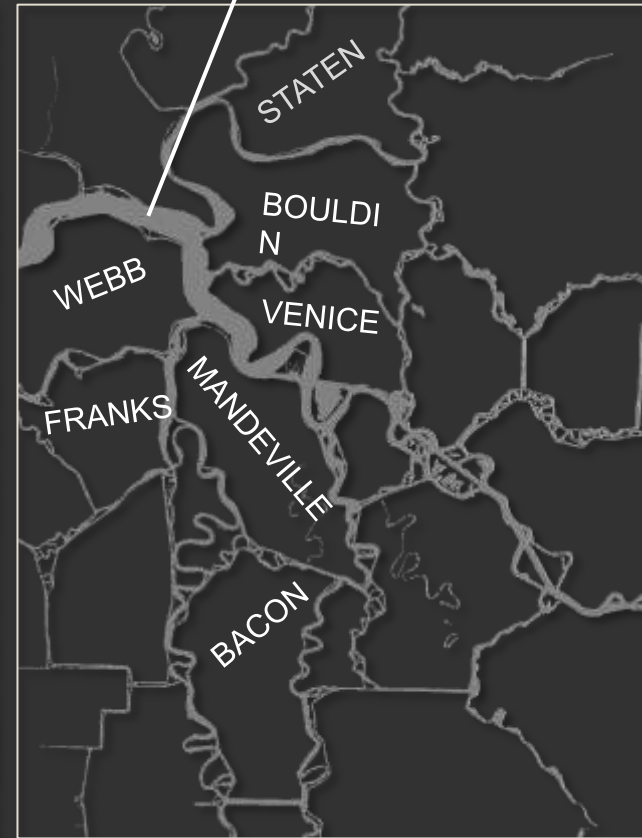


Central Delta: where tides dominate

- Numerous sinuous tidal channels of different sizes
- Organized into networks branching into wetland



early 1800s



early 2000s

Central Delta: where tides dominate

CAUSED BY "CUTS".

The San Joaquin Almost
Unnavigable.

EXCEPT AT HIGH TIDE.

Unexpected Result of Shortening
the River.

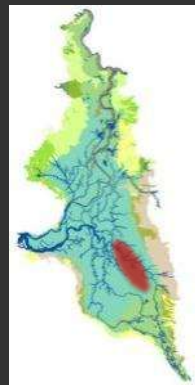
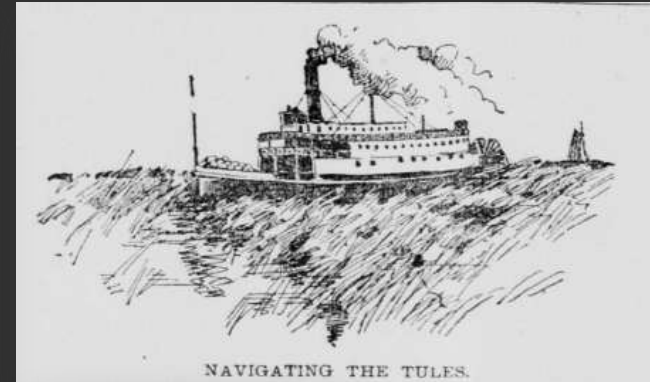
In the old days, when the river twisted like a snake, the rise and fall of the tide in the bay did not make a difference in the San Joaquin between Stockton and Twenty-one Mile Slough of more than two feet. The reason of this was that the many curves in the stream prevented the water running out as fast as the tide fell. By the time the tide had fallen six feet in the bay the water fell only two feet in the river, and when the tide rose in the bay it caught the flood and the river commenced to rise again. By this natural phenomenon the river was navigable at all hours. "But now things have changed," said Pilot Arthur Robinson yesterday, "and the water runs through those cuts at low tide as it would out of a tin pan. The tide

"In the old days, when the river twisted like a snake, the rise and fall...did not make a difference...of more than two feet."

"...the many curves...prevented the water running out as fast as the tide fell."

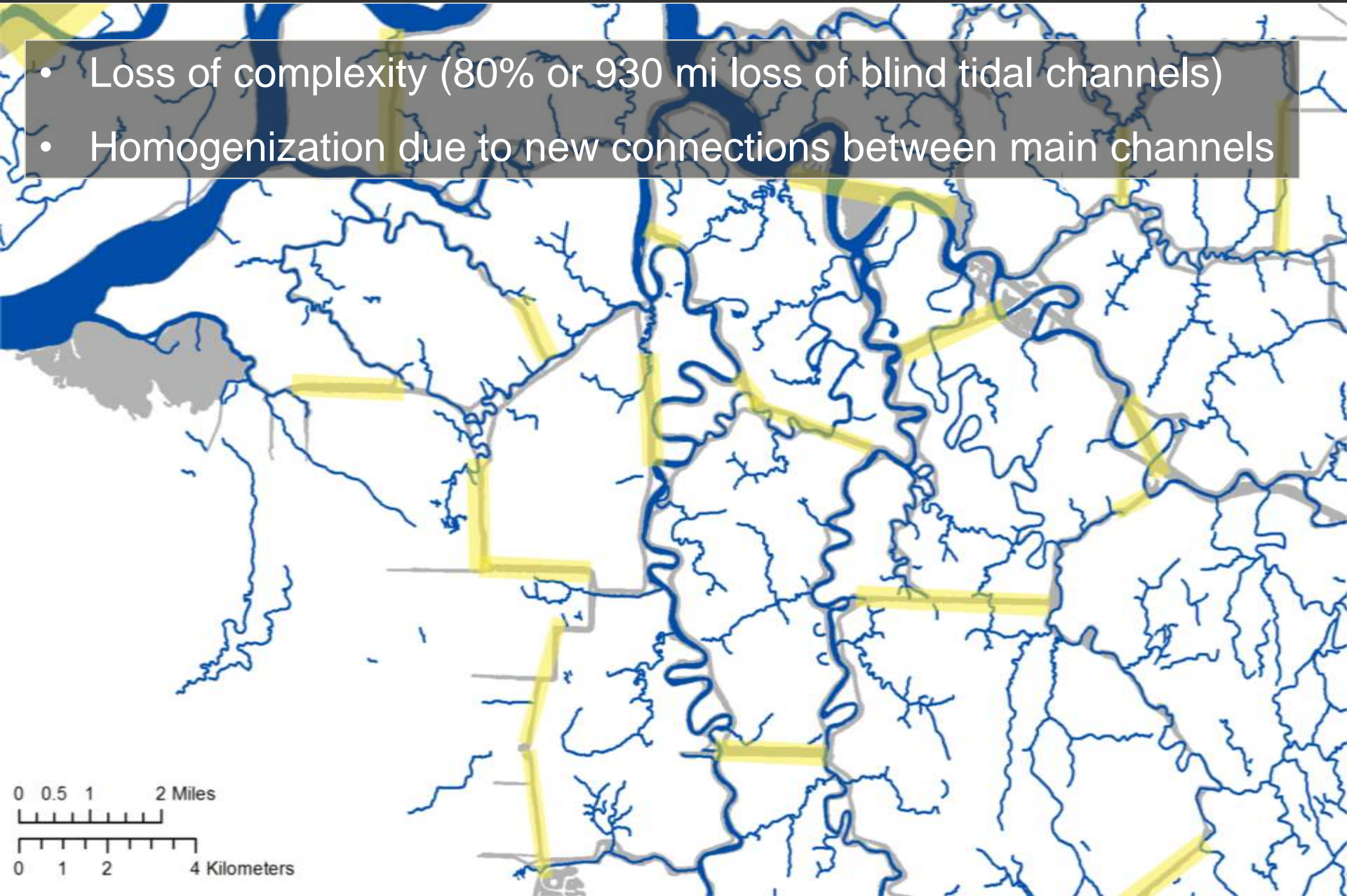
"...the river was navigable at all hours."

"...now things have changed...the water runs through those cuts...as it would out of a tin pan."



Central Delta: where tides dominate

- Loss of complexity (80% or 930 mi loss of blind tidal channels)
- Homogenization due to new connections between main channels



Central Delta: where tides dominate

- Diverse vegetation community including willow-fern swamp

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Comparing the central Delta to the north Delta:

“Interior parts the tule is thinner and shorter. Willows here grow in bunches...”

- USDA 1874

*Gibbes 1850, courtesy of UC
Davis Shields Library*

Central Delta: where tides dominate

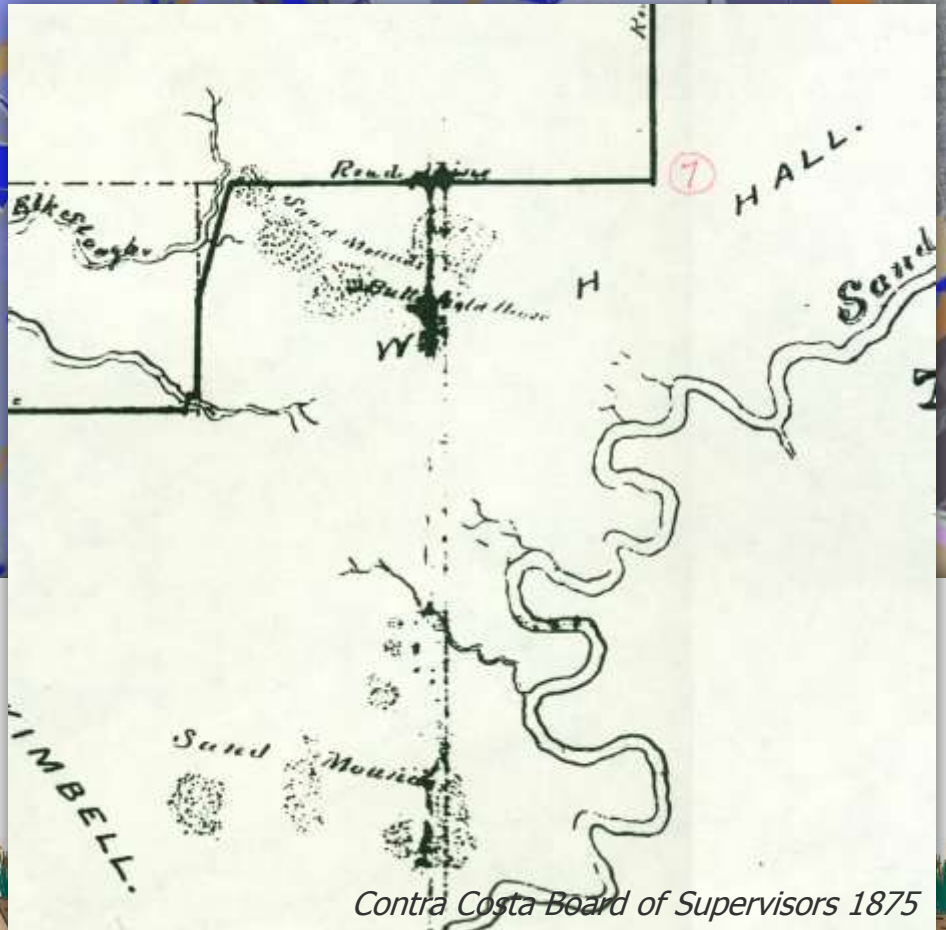
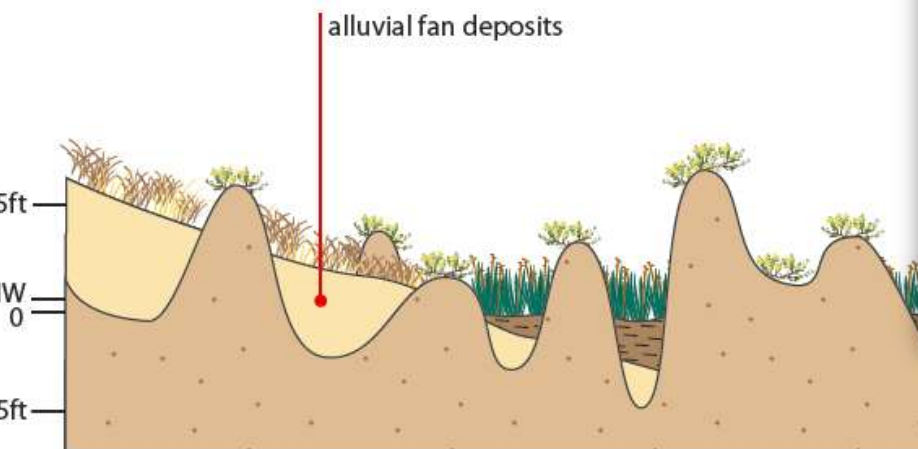
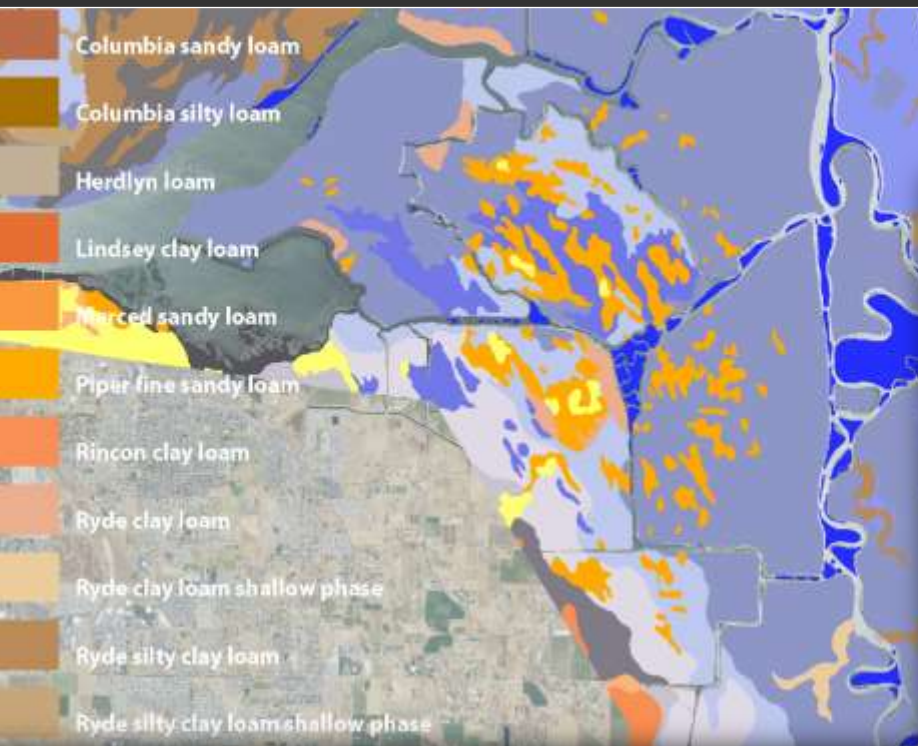
- Diverse vegetation community including willow-fern swamp

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Photo by Daniel Burmester

Central Delta: where tides dominate



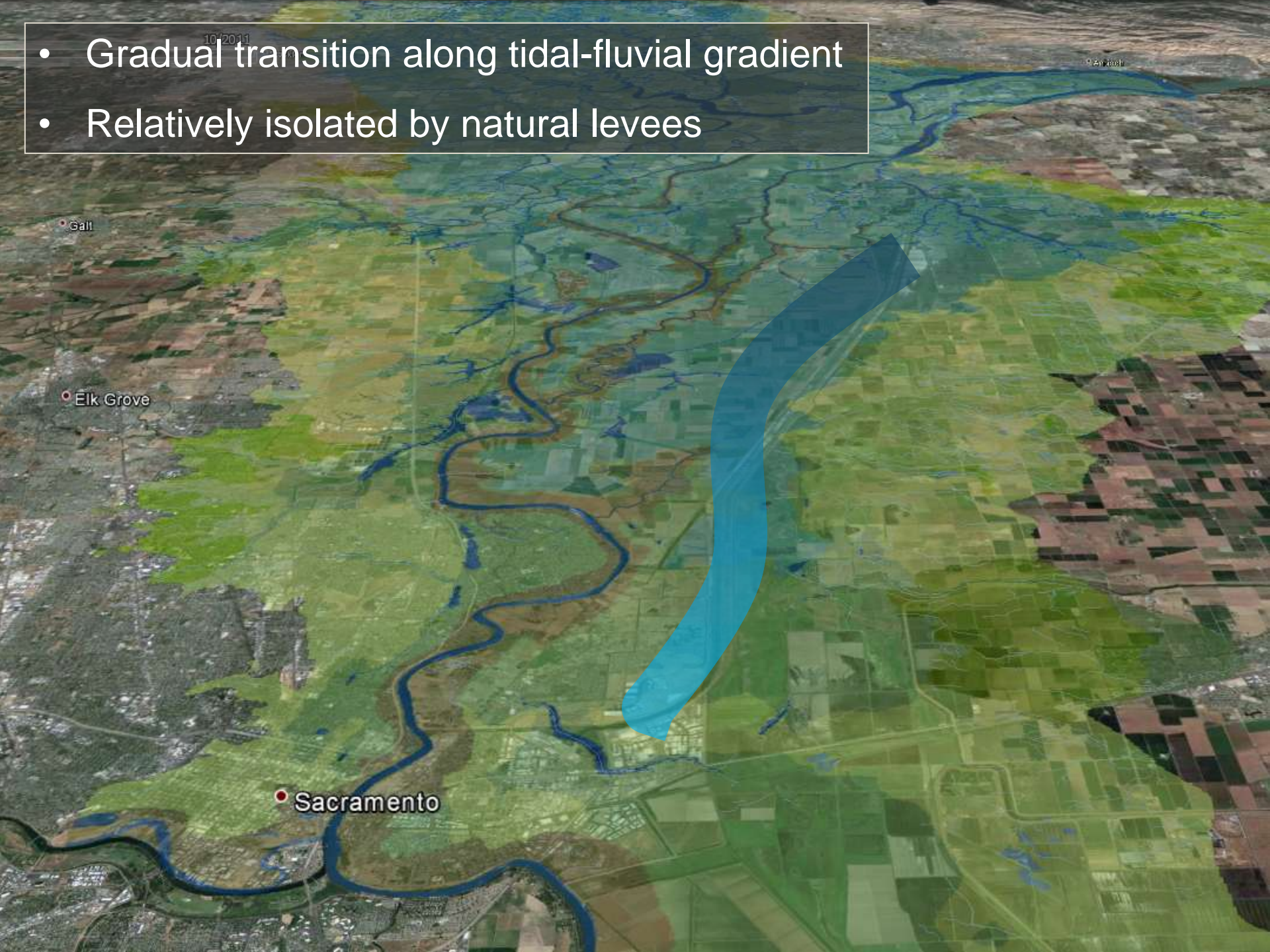
Contra Costa Board of Supervisors 1875

3.1 miles

North Delta: where flood basins flank rivers



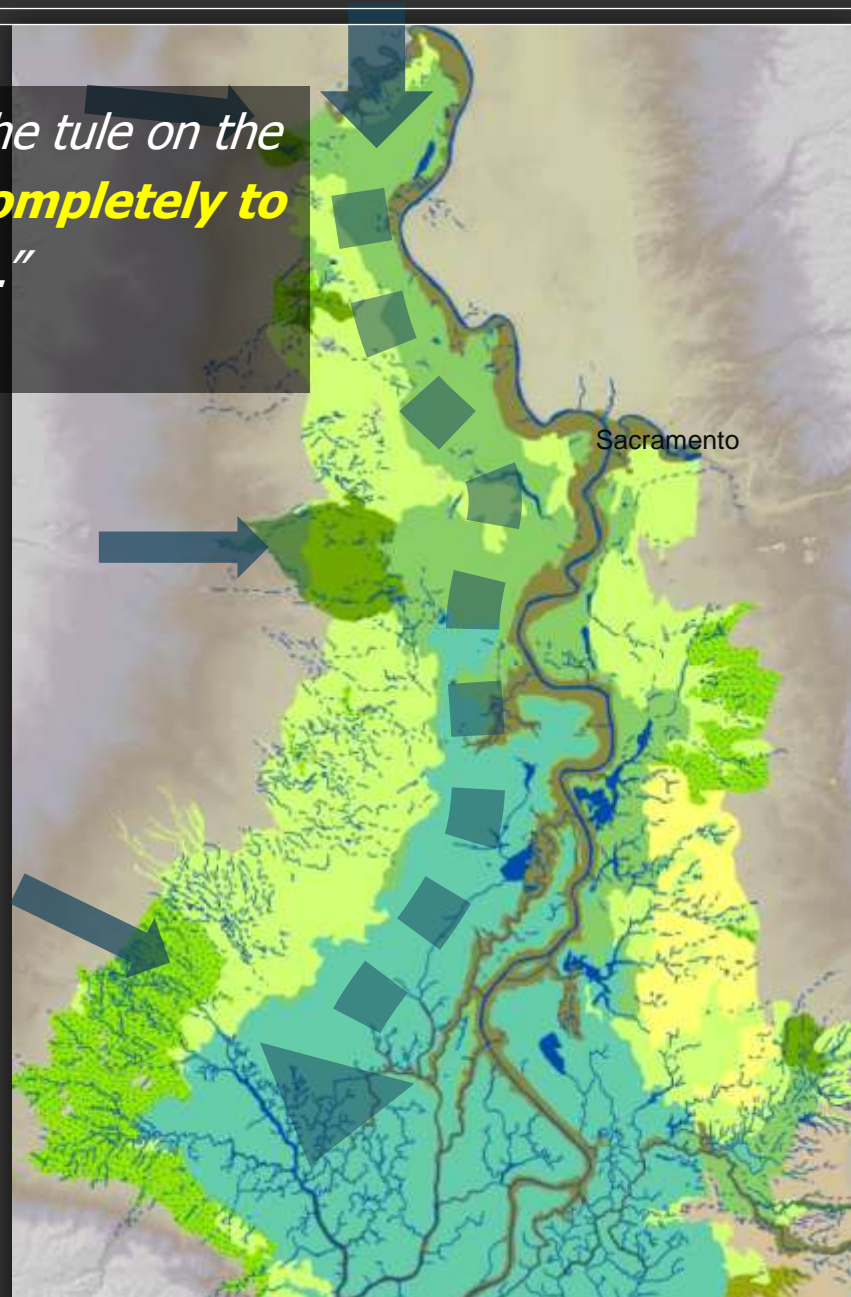
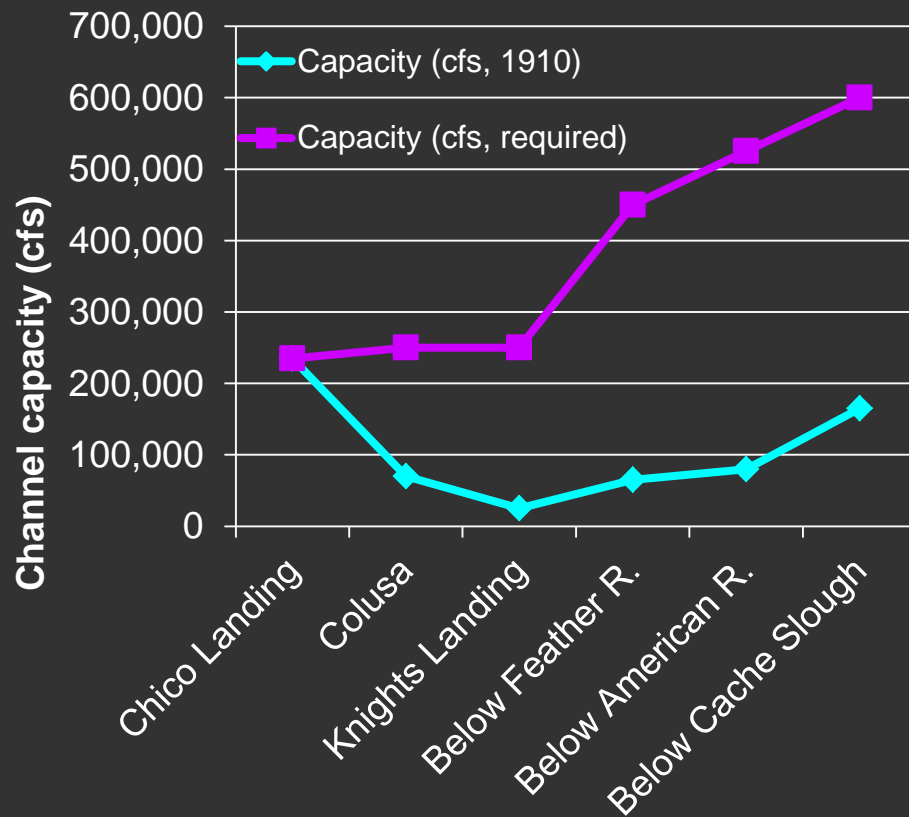
- Gradual transition along tidal-fluvial gradient
- Relatively isolated by natural levees



North Delta: where flood basins flank rivers

*"...the water pours down Cache slough from the tule on the west in such volume and with such force as **completely to neutralize the current** in Steamboat slough."*

- Sacramento Daily Union, 24 March 1862

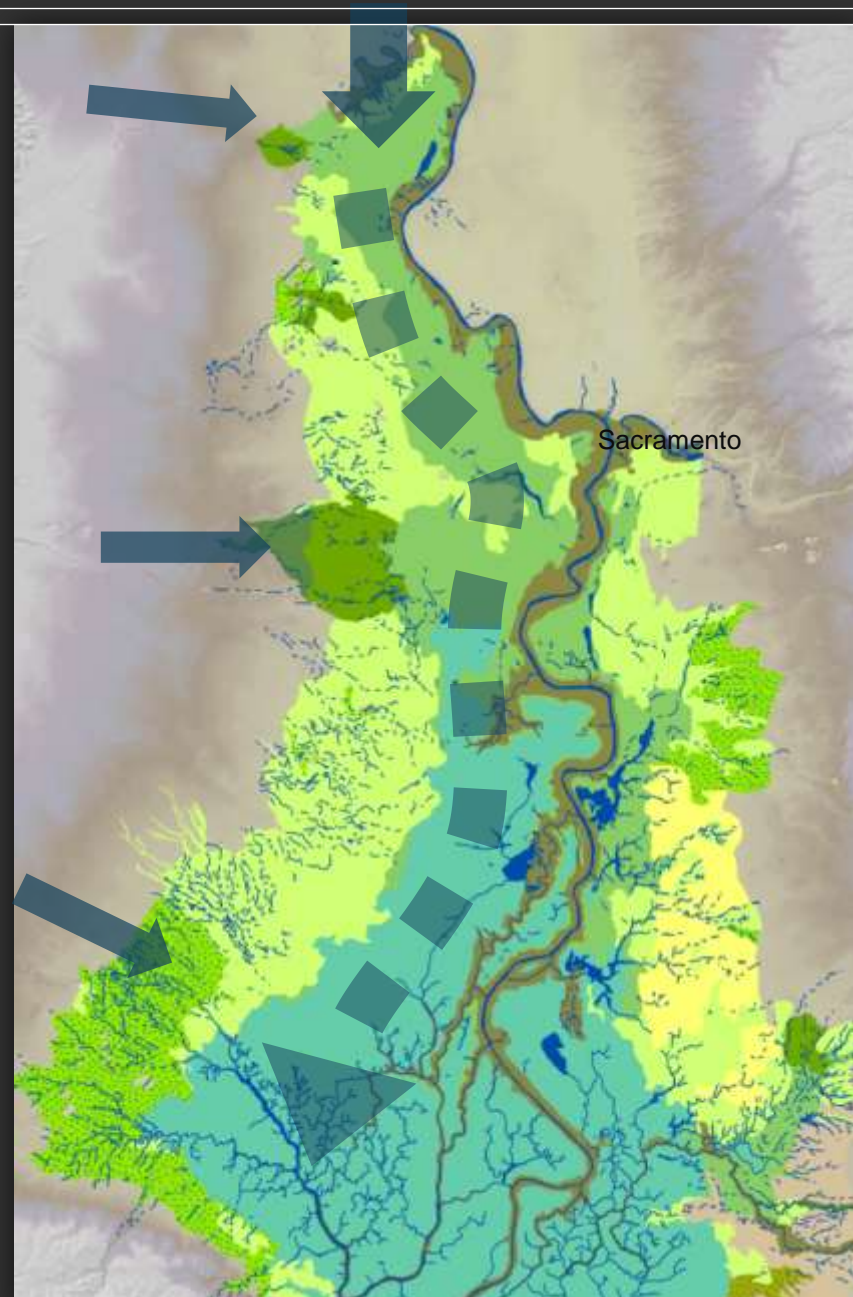
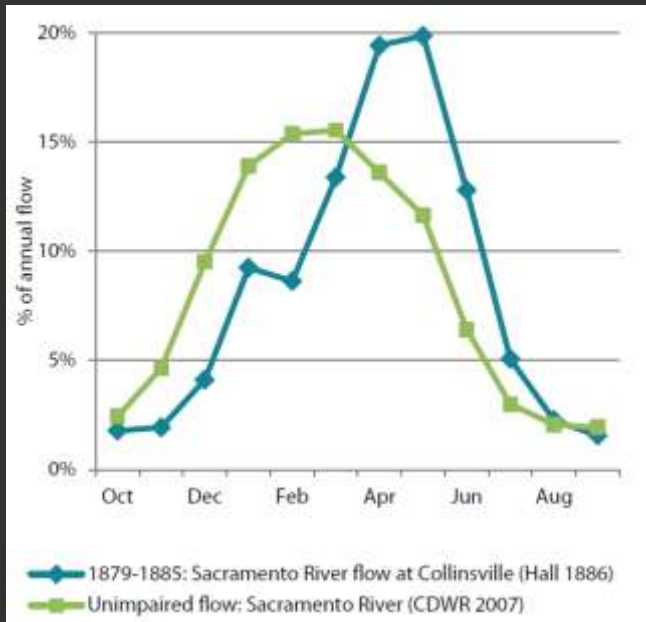


North Delta: where flood basins flank rivers

- Basins attenuated flood flows
- Floods connected components

*“the great basins...act as **enormous regulating reservoirs**...to cut down the crest of the great flood waves”*

- Dabney Commission 1905

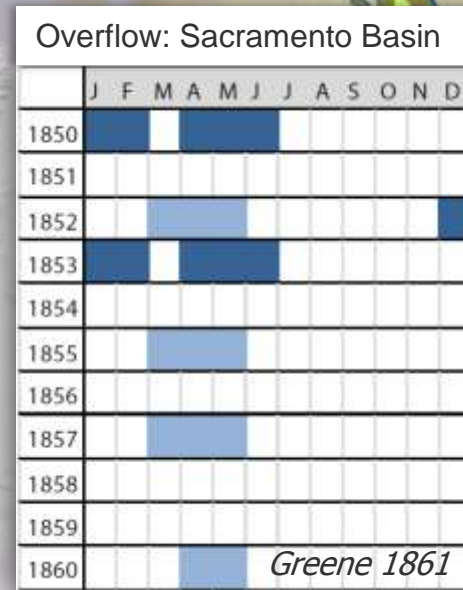


North Delta: where flood basins flank rivers

- Wet late into summer
- Seasonal and inter-annual variability

*“...**creeping slowly** along toward tide water, **not in a direct or free channel**... thoroughly saturated with water until later in the summer months”*

- Board of Swamp Land Commissioners 1864



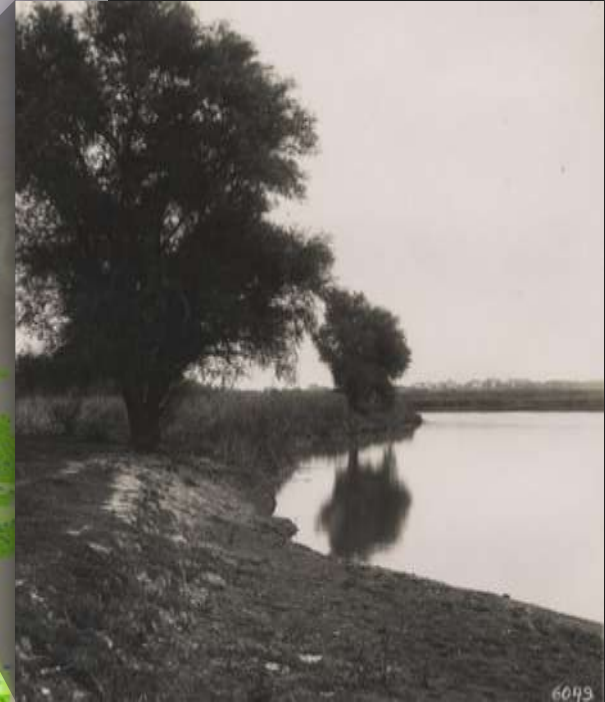
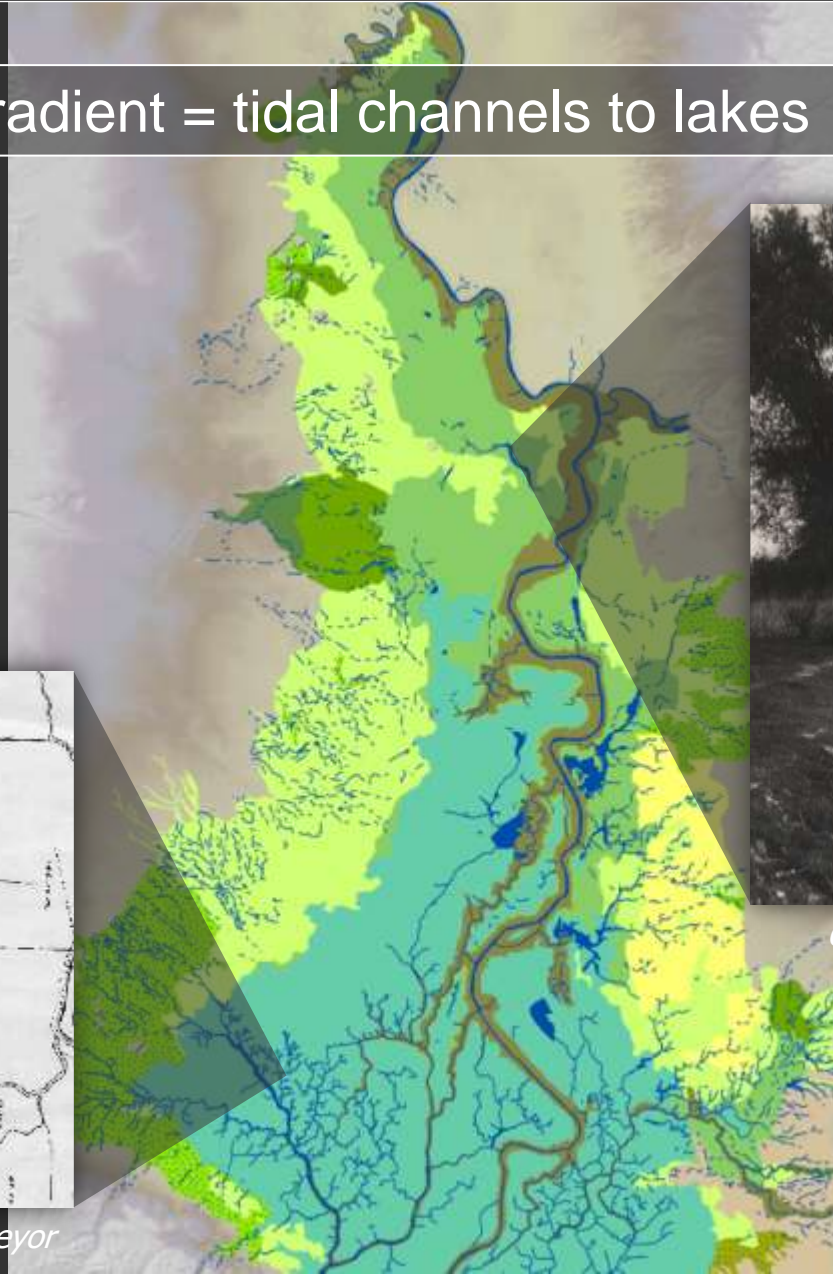
North Delta: where flood basins flank rivers

- Tidal to fluvial gradient = tidal channels to lakes

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Courtesy of Solano County Surveyor



Courtesy of California State Library

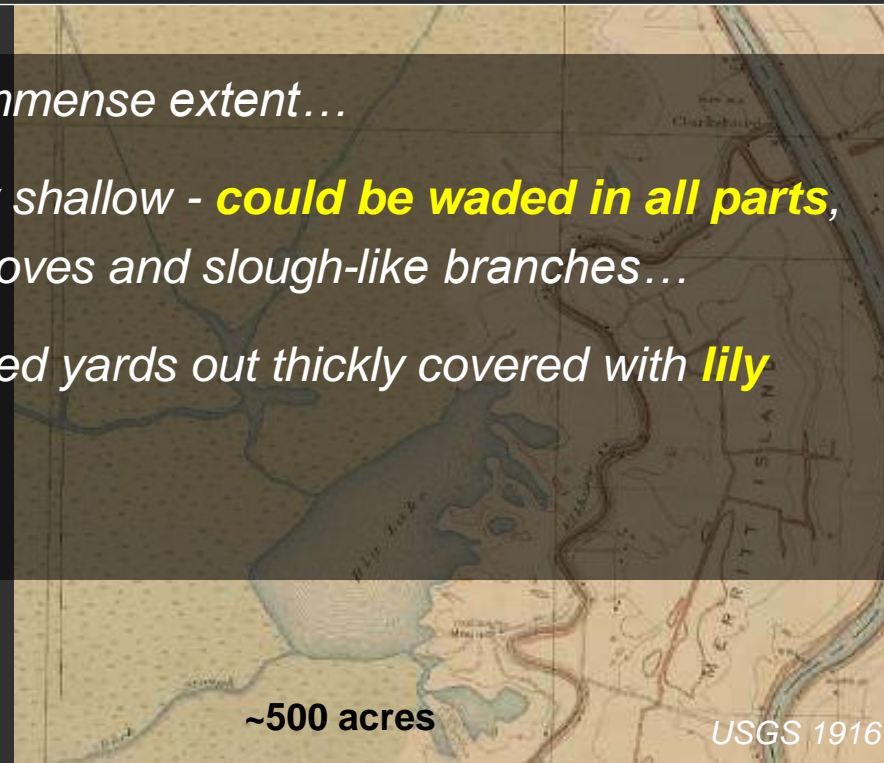
North Delta: where flood basins flank rivers

“Far out in an impenetrable tule swamp of immense extent...

*Though the lake was a large one it was very shallow - **could be waded in all parts**, except a small streak in the middle...many coves and slough-like branches...*

*Edge of the lake for a distance of one hundred yards out thickly covered with **lily pads**.”*

- Wright ca. 1850



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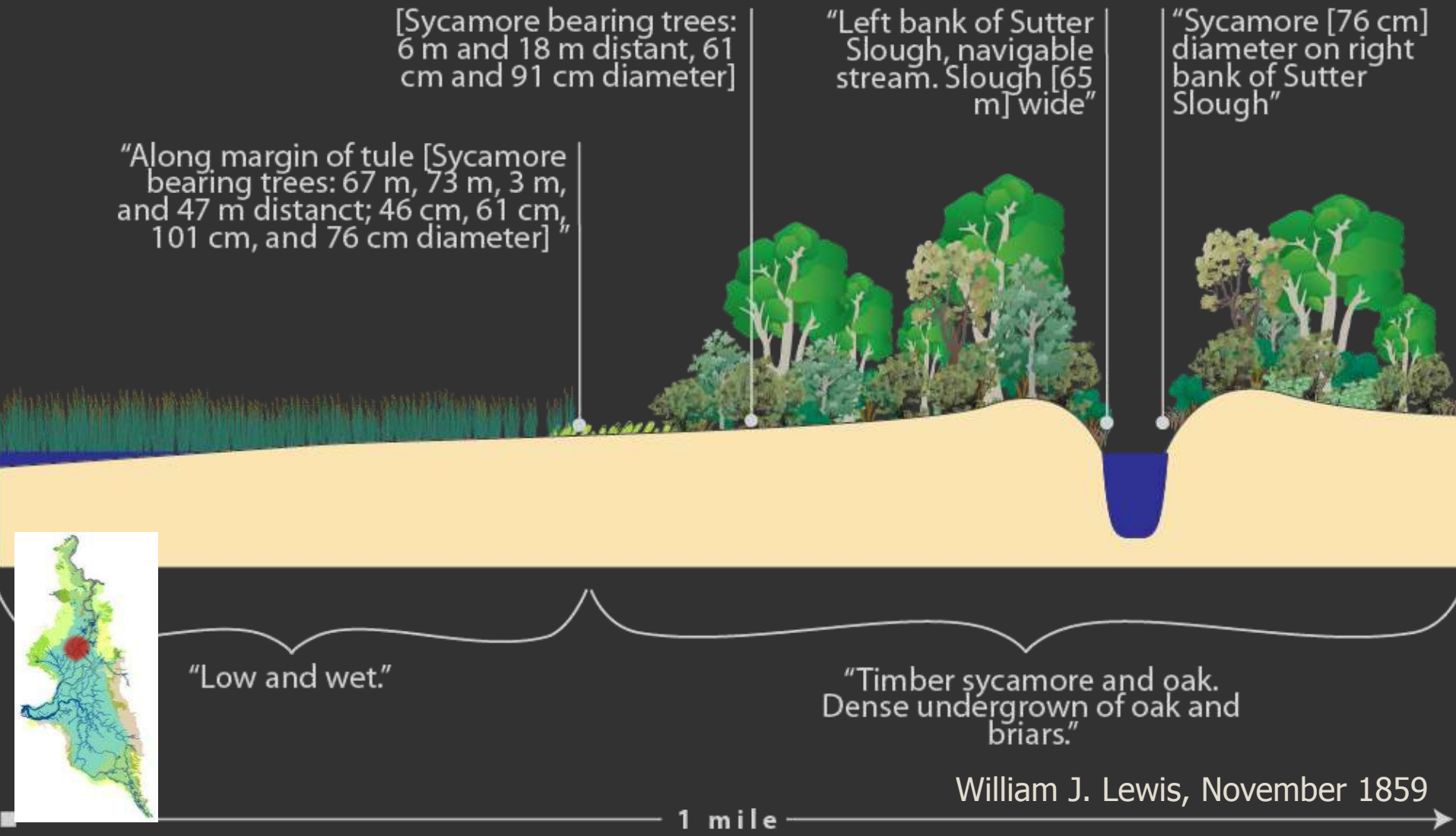
North Delta: where flood basins flank rivers

- Dense and structurally complex riparian forest

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North Delta: where flood basins flank rivers

- Riparian forest on natural levees bounded flood basins





South Delta: where floodplains meet tides

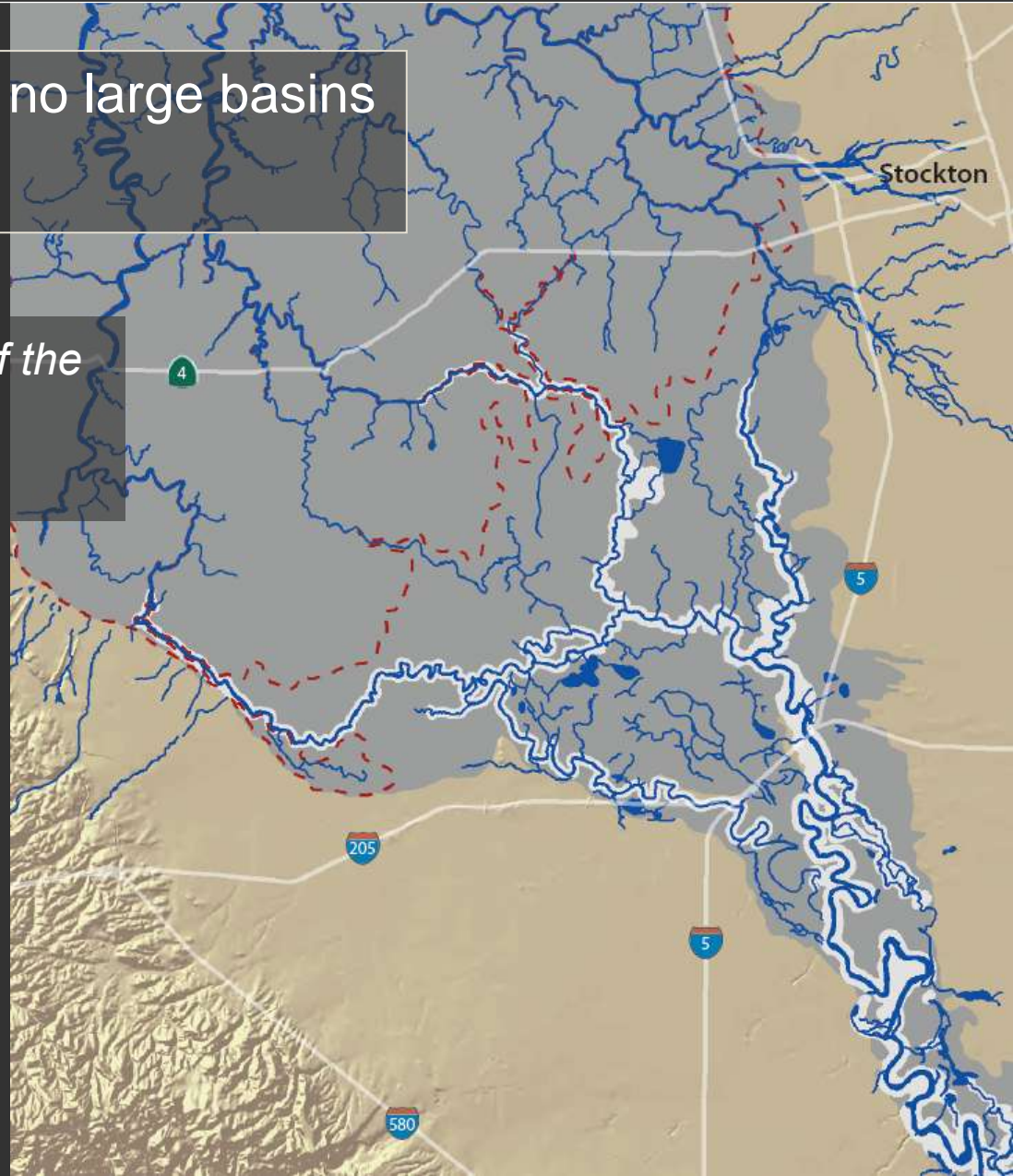


South Delta: where floodplains meet tides

- Broadening floodplain with no large basins
- Wet late into summer

“Inundated during the high water of the rivers, which is in the summer.”

- Viader 1810



A detailed topographic map of the San Joaquin River area. The river is shown in blue, winding through the landscape. Various features are labeled, including 'Sewage Disposal Ponds', 'Walthall RANCH', 'GAS Slough', 'DE RUE RD', 'PERRIN ROAD', 'HOMESTEAD ROAD', 'CAVAL', 'Pumping Station No 1', 'BM 41', 'BM 24', 'BM 25', 'WRIGHT ROAD', 'LORENZ ROAD', 'MILE 61', 'Gas Well', 'Sandpit', 'FIELD', 'AIRPORT', 'ROAD', 'WAY', 'R6E', 'R6E', 'R7E', 'R7E', 'R8E', 'R8E', 'R9E', 'R9E', 'R10E', 'R10E', 'R11E', 'R11E', 'R12E', 'R12E', 'R13E', 'R13E', 'R14E', 'R14E', 'R15E', 'R15E', 'R16E', 'R16E', 'R17E', 'R17E', 'R18E', 'R18E', 'R19E', 'R19E', 'R20E', 'R20E', 'R21E', 'R21E', 'R22E', 'R22E', 'R23E', 'R23E', 'R24E', 'R24E', 'R25E', 'R25E', 'R26E', 'R26E', 'R27E', 'R27E', 'R28E', 'R28E', 'R29E', 'R29E', 'R30E', 'R30E', 'R31E', 'R31E', 'R32E', 'R32E', 'R33E', 'R33E', 'R34E', 'R34E', 'R35E', 'R35E', 'R36E', 'R36E', 'R37E', 'R37E', 'R38E', 'R38E', 'R39E', 'R39E', 'R40E', 'R40E', 'R41E', 'R41E', 'R42E', 'R42E', 'R43E', 'R43E', 'R44E', 'R44E', 'R45E', 'R45E', 'R46E', 'R46E', 'R47E', 'R47E', 'R48E', 'R48E', 'R49E', 'R49E', 'R50E', 'R50E', 'R51E', 'R51E', 'R52E', 'R52E', 'R53E', 'R53E', 'R54E', 'R54E', 'R55E', 'R55E', 'R56E', 'R56E', 'R57E', 'R57E', 'R58E', 'R58E', 'R59E', 'R59E', 'R60E', 'R60E', 'R61E', 'R61E', 'R62E', 'R62E', 'R63E', 'R63E', 'R64E', 'R64E', 'R65E', 'R65E', 'R66E', 'R66E', 'R67E', 'R67E', 'R68E', 'R68E', 'R69E', 'R69E', 'R70E', 'R70E', 'R71E', 'R71E', 'R72E', 'R72E', 'R73E', 'R73E', 'R74E', 'R74E', 'R75E', 'R75E', 'R76E', 'R76E', 'R77E', 'R77E', 'R78E', 'R78E', 'R79E', 'R79E', 'R80E', 'R80E', 'R81E', 'R81E', 'R82E', 'R82E', 'R83E', 'R83E', 'R84E', 'R84E', 'R85E', 'R85E', 'R86E', 'R86E', 'R87E', 'R87E', 'R88E', 'R88E', 'R89E', 'R89E', 'R90E', 'R90E', 'R91E', 'R91E', 'R92E', 'R92E', 'R93E', 'R93E', 'R94E', 'R94E', 'R95E', 'R95E', 'R96E', 'R96E', 'R97E', 'R97E', 'R98E', 'R98E', 'R99E', 'R99E', 'R100E', 'R100E'.

Approaching the San Joaquin Crossing (near I-5 today):

*“There were more **ponds, swamps and sloughs**...The first of these places had about three feet of water, but the bottom was solid and we crossed it without difficulty. The second was a slough more than fifty meters long where one went at random...The third was a little lake.*

*There we were lucky enough to find a **balsa of tules** or an immense bundle of reeds or bullrushes tied together, **on which we took over our saddles, our baggage and ourselves.***

Towards two o'clock we reached the lagoon where an American had perished a few days before.”

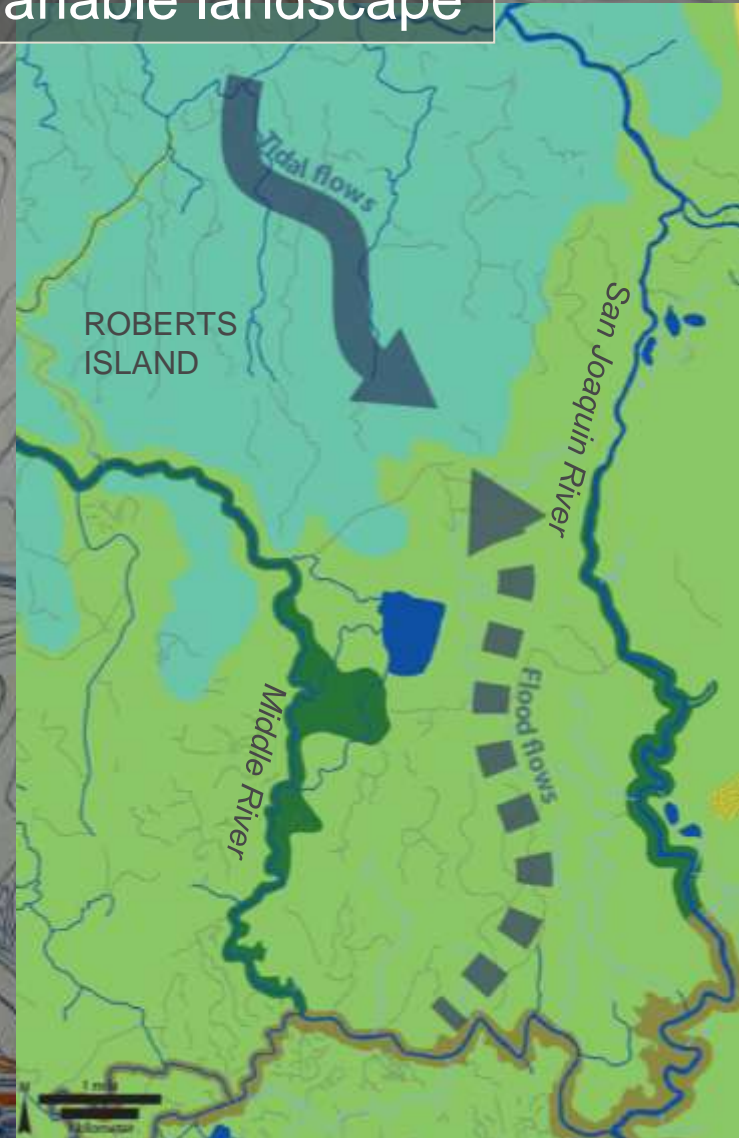
- Jacques Moerenhout, July 13, 1848

South Delta: where floodplains meet tides

- Complex flows across topographically variable landscape

*"These discharge into **small lakes or spread out** in the tule, and are **drained off by the slues**"*

- Gibbes 1850

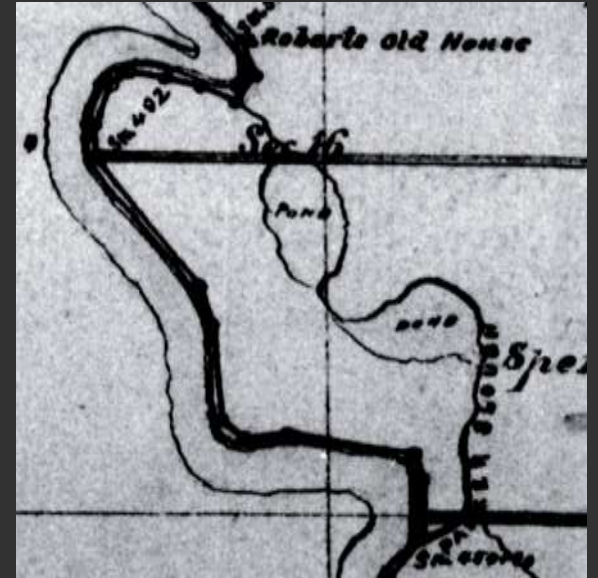


South Delta: where floodplains meet tides

- Lakes and ponds connected to rivers

*“Along the edge of the lowland...a **string of lakes connected by sloughs** extend throughout the greater part of the area.”*

- Sweet et al. 1908



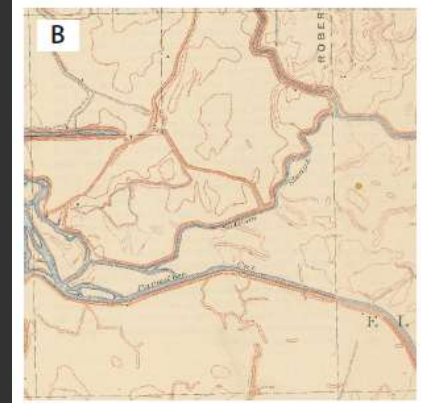
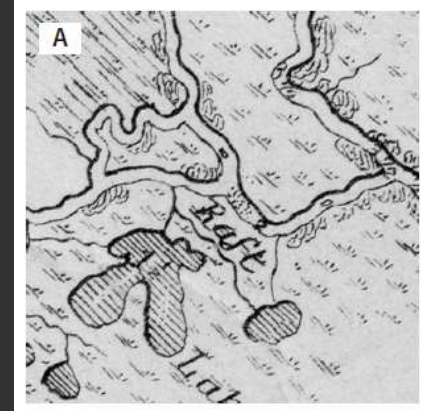
South Delta: where floodplains meet tides

- Channel complexity

Salmon Slough: “The stream bed is **full of logs** and the boats grounded two or three times.” (Abella 1811)

“I came to a **raft of large timber**, and after some hard work in cutting and sawing logs, we succeeded in dragging our boat through.” (Gibbes 1850)

“...great many **old logs and an immense amount of driftwood** and rubbish in Old River” (Tucker Field Notes 1879)



South Delta: where floodplains meet tides

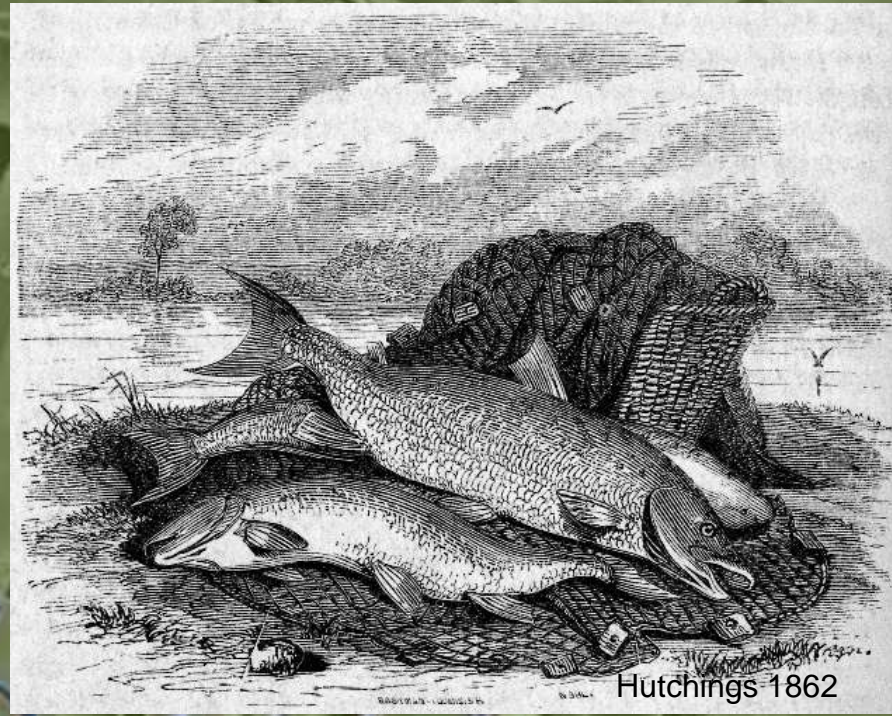
“Río del Pescadero [Old River]...**fishing is done in it for salmon.**”

(Cook 1960, “Report of Hermenegildo Sal,” January 31, 1796)

“...it was **salmon, tenderer, fatter, and more savory**...for perhaps because there is so much fresh water here it grows larger, fatter, and better flavored.”

(Bolton [ed] 1927, “Anza’s California Expeditions” 1776)

“...we rested here [El Pescadero] and passed the time well with **fresh salmon** and wild grapes” (Cook 1960, “Father Vaider's Second Trip,” October 29, 1810)

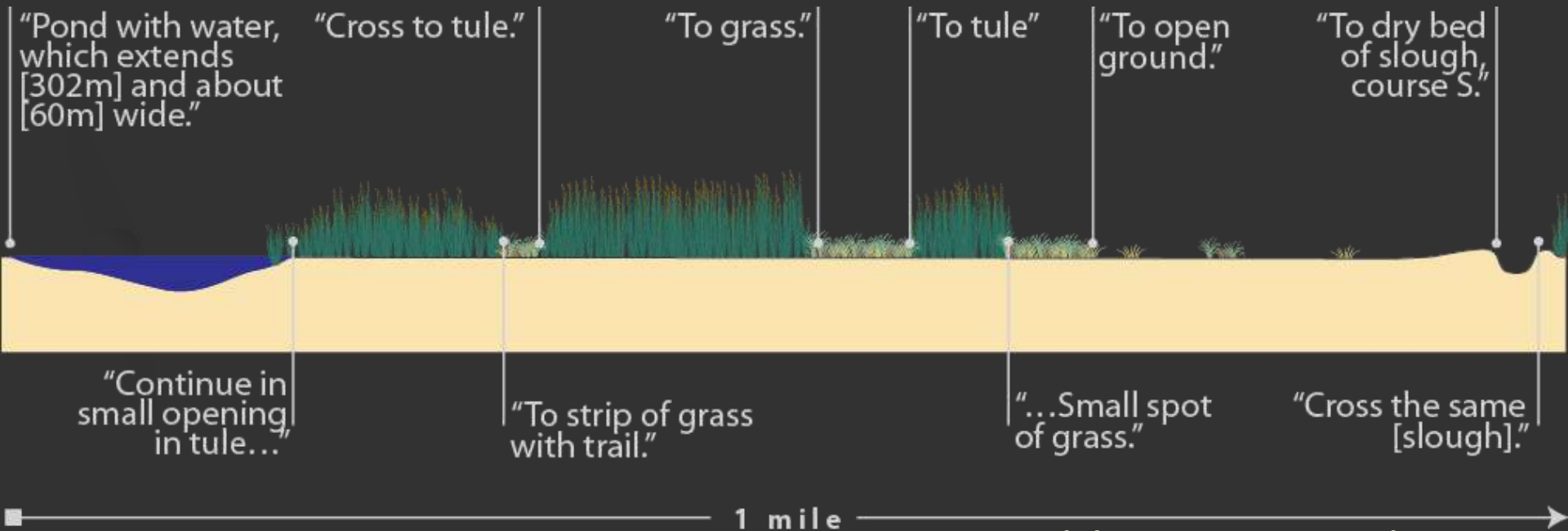


South Delta: where floodplains meet tides

- Diverse suite of habitat types at local-scale



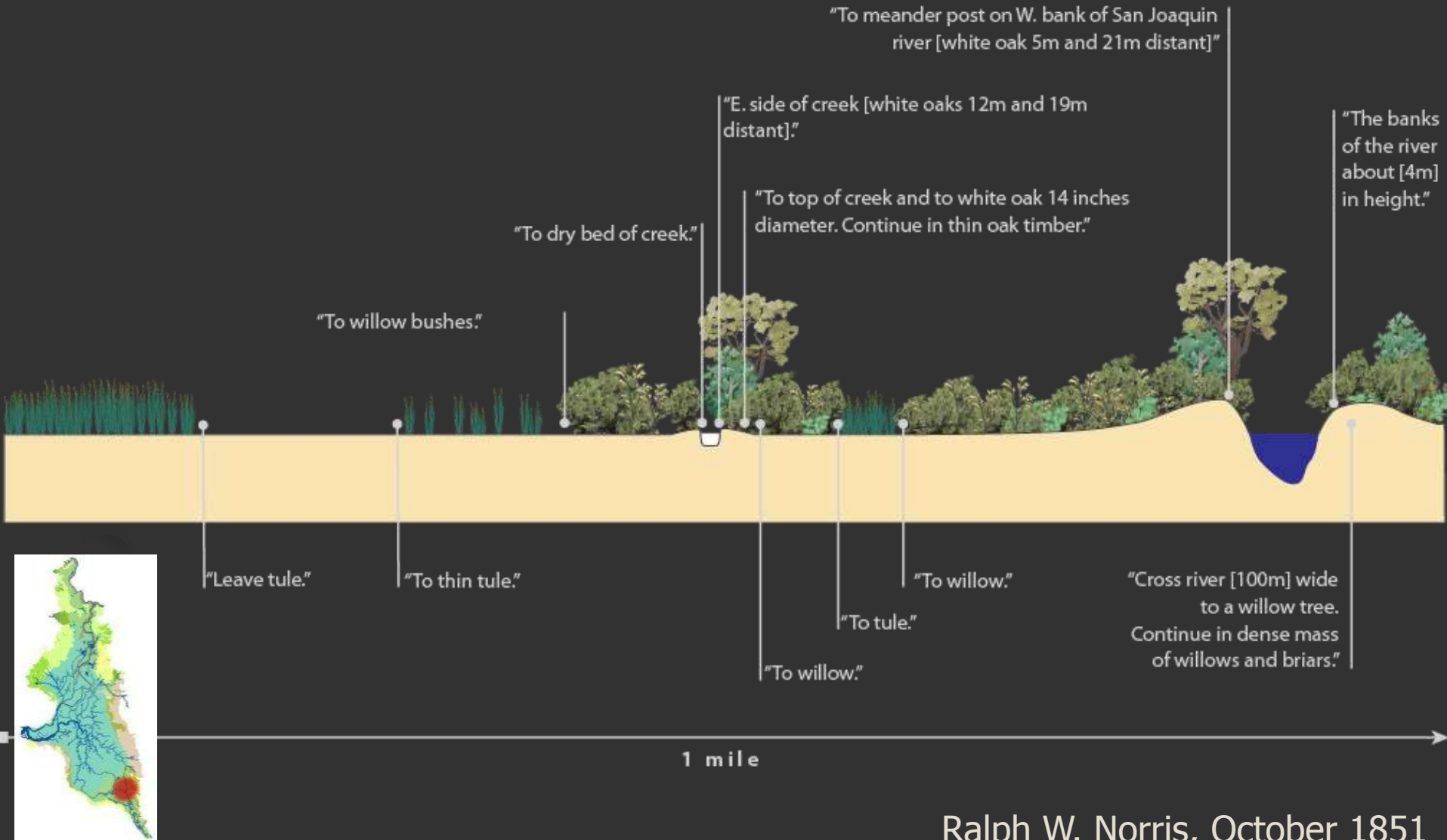
Laura Cunningham 2010



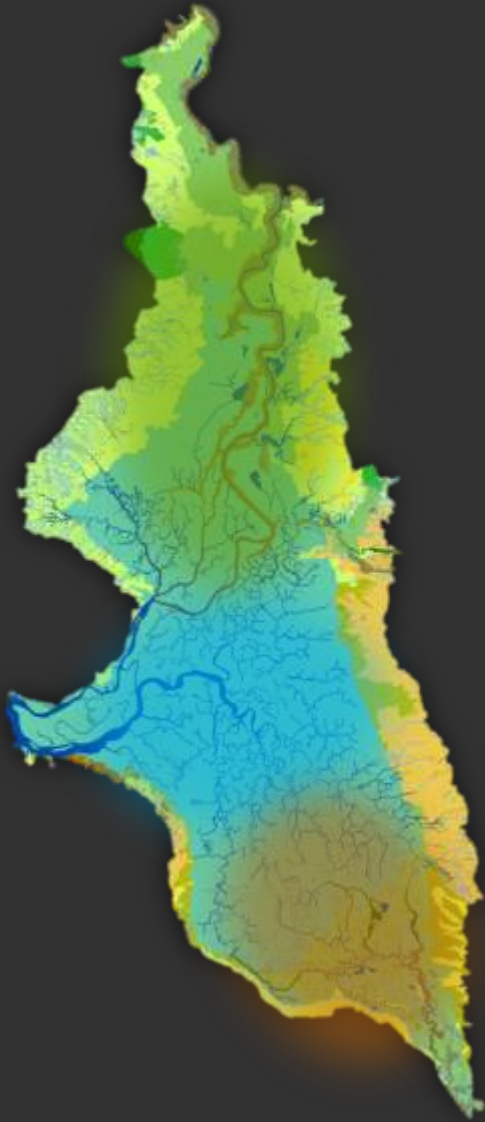
Ralph W. Norris, October 1851

South Delta: where floodplains meet tides

- Diverse suite of habitat types at local-scale



Landscapes summary



- Floods wetted and connected landscape
- Channels to lakes along gradient
- Riparian forest bordering tule basins



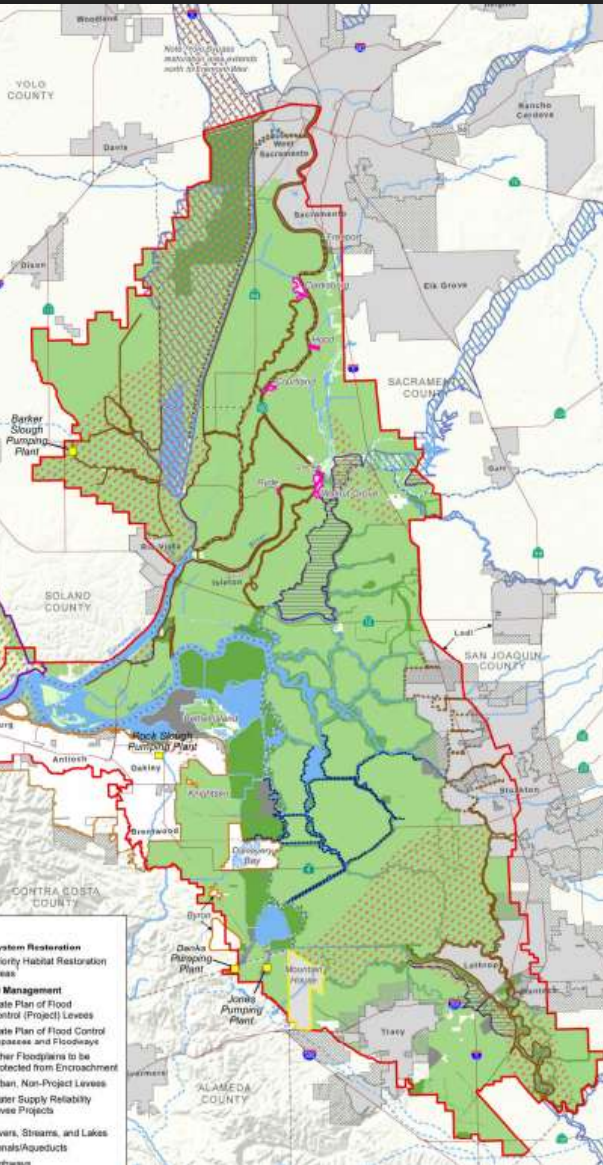
- High degree of tidal influence
- Networks of branching channels
- Tidal wetland of tule and willow-fern swamp



- Floods within a complex landscape meet the tides
- Side-channels connected to rivers
- Habitat type diversity at local scale



Implications



- Floodplain inundation
- Downstream connectivity through perennial wetland
- Adjacent riparian forest



- Appropriate elevation
- Tidal energy
- Scale of channel networks



- Floodplain inundation
- Dynamic river processes
- Topographic complexity



Figure 1-3, The Delta Plan

Talk outline

- What is historical ecology and why is it useful?
- How do we do historical ecology?
- Findings of the *Delta Historical Ecology Investigation*
- How is this information being used?

What is a realistic but positive vision for the future Delta?

- Importance of a positive message, something worth getting excited about
- Not just for healthy, resilient native fish and wildlife but healthy resilient human communities
- Importance of a narrative – a compelling, well-documented story of what we had, how we got here, and what could be done in the future

→ *Visualizations of what this landscape could look like in the future*

The Delta Landscapes Project

Management Tools for Landscape-Scale Restoration

Funded by the Ecosystem Restoration Program



Project approach

- How and where were desired ecological functions provided in a healthy Delta?
- How do we measure and quantify these functions?
- What constituted a functional landscape?
- Where could functional landscapes be supported today?
- What is a realistic vision for the future Delta?

Landscape Interpretation Team

Brian Atwater (USGS)

Stephanie Carlson (UC Berkeley)

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Brian Collins (University of Washington)

Chris Enright (Delta Science Program)

Joseph Fleskes (USGS)

Geoffrey Geupel (PRBO Conservation Science)

Todd Keeler-Wolf (CDFG)

William Lidicker (UC Berkeley)

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Jeff Mount (UC Davis)

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Anke Mueller-Solger (IEP and Delta Science Program)

Eric Sanderson (Wildlife Conservation Society)

John Wiens (PRBO Conservation Science)

Dave Zezulak (CDFG)

What constituted a functional landscape?

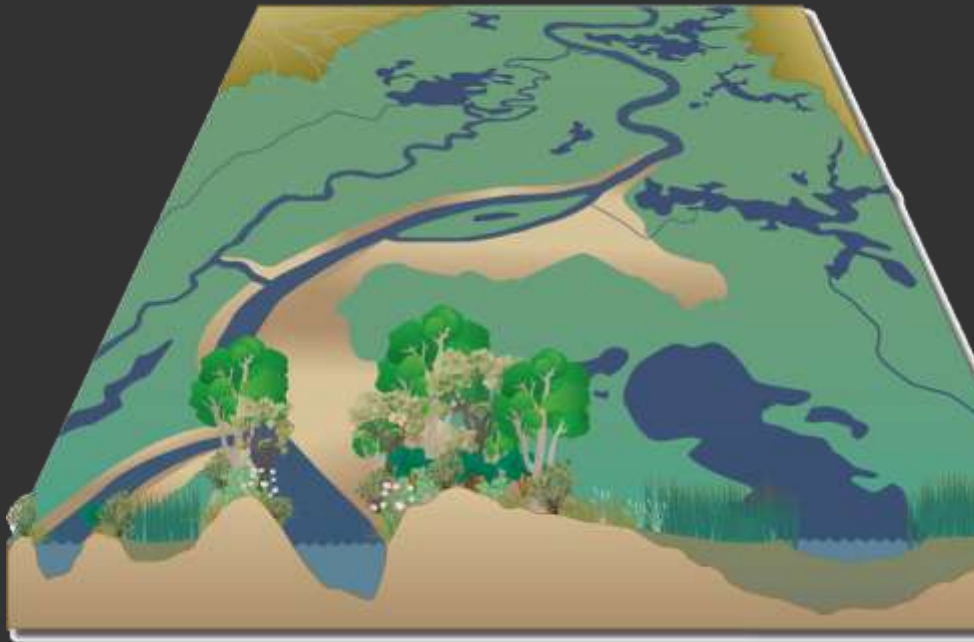
ecological
functions

+

physical
drivers

=

operational landscape
unit



Example **landscape unit** attributes

to be determined through landscape metrics analysis

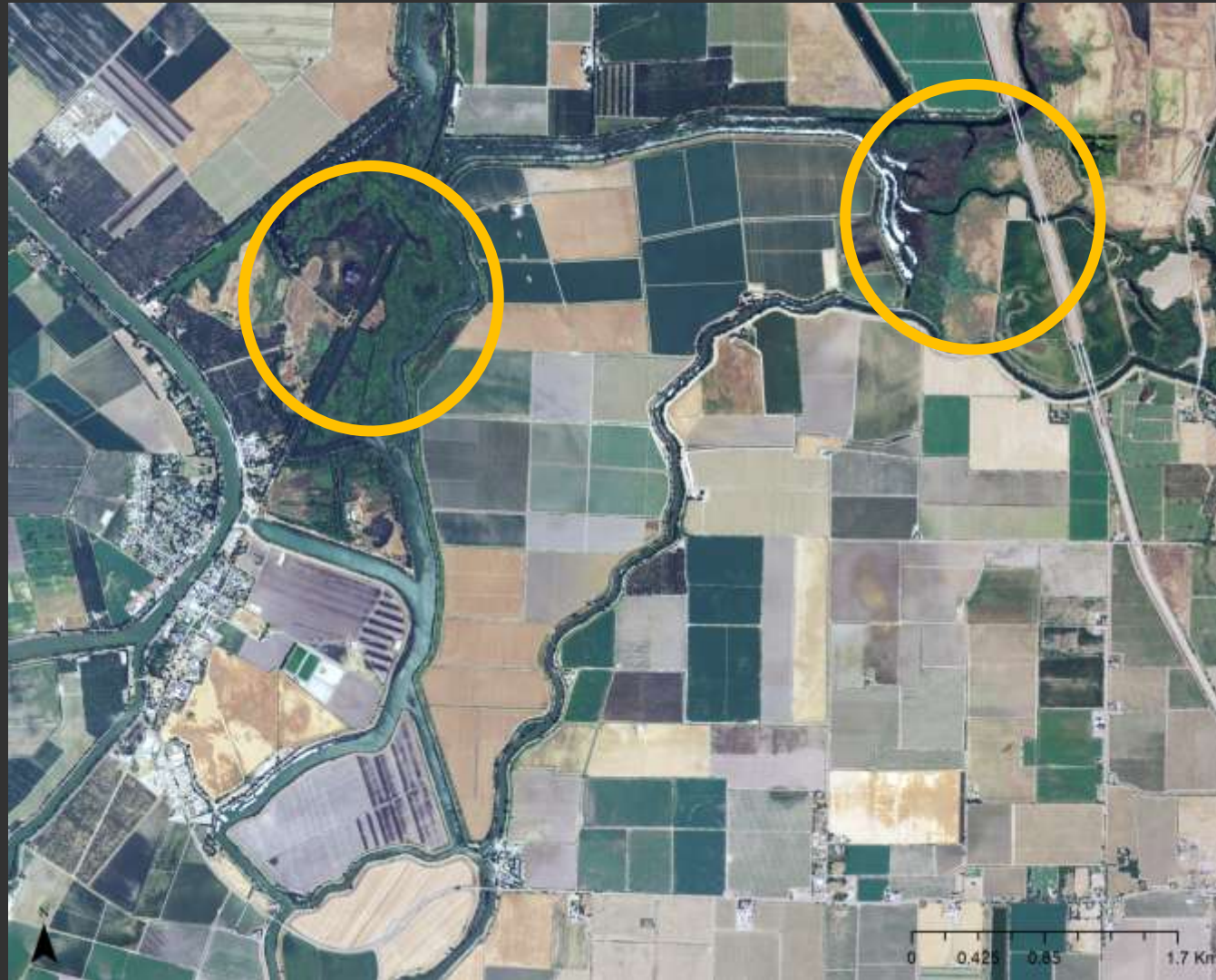
- {XX frequency} tidal inundation
- {XX frequency} fluvial inundation
- {XX ha} ponds and lakes adjacent to channels
- Broad natural levees {XX m} high
- Riparian forest {XX m} wide
- {XX m/m²} tidal channels
- ...

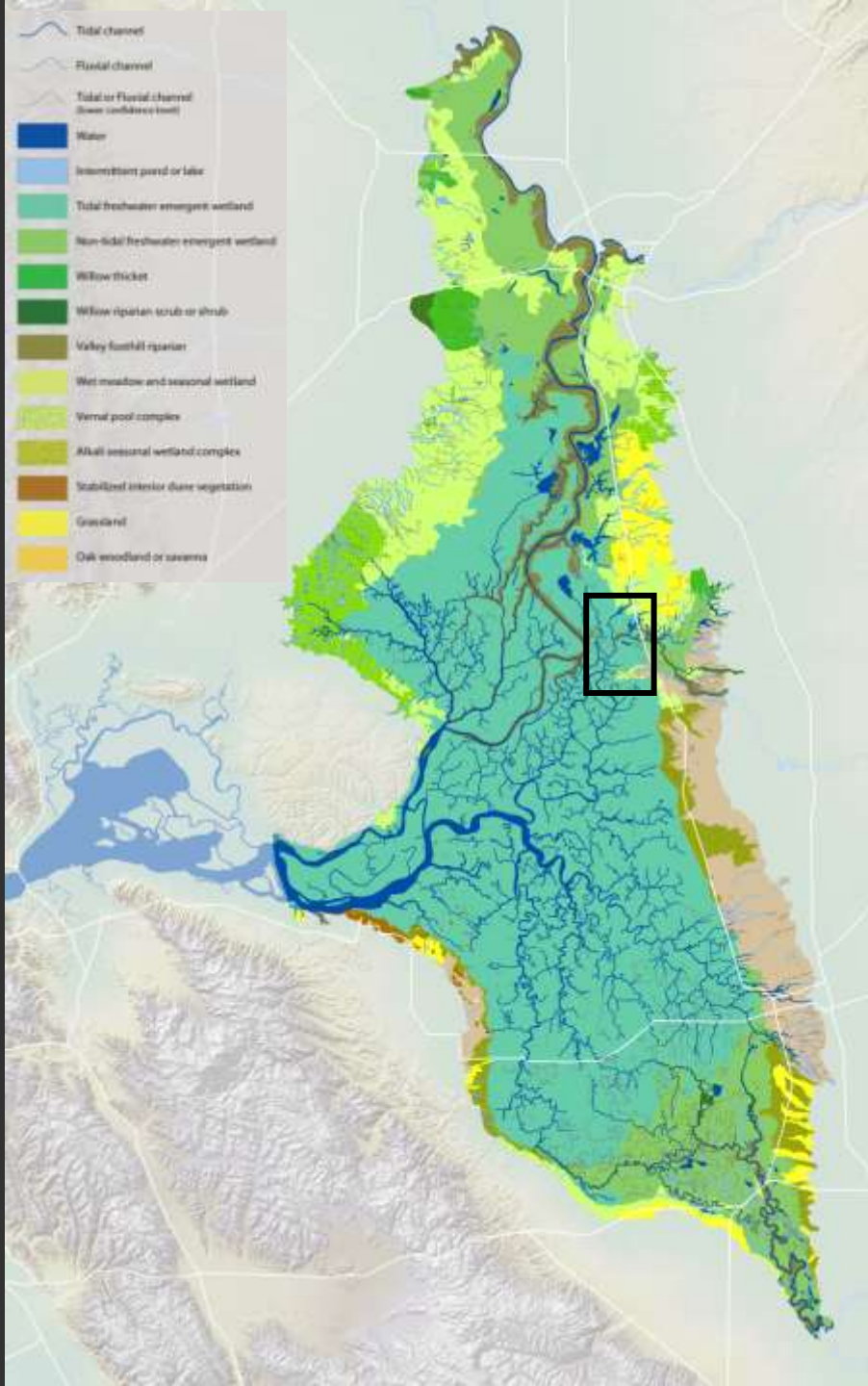
Where could functional landscapes be today?

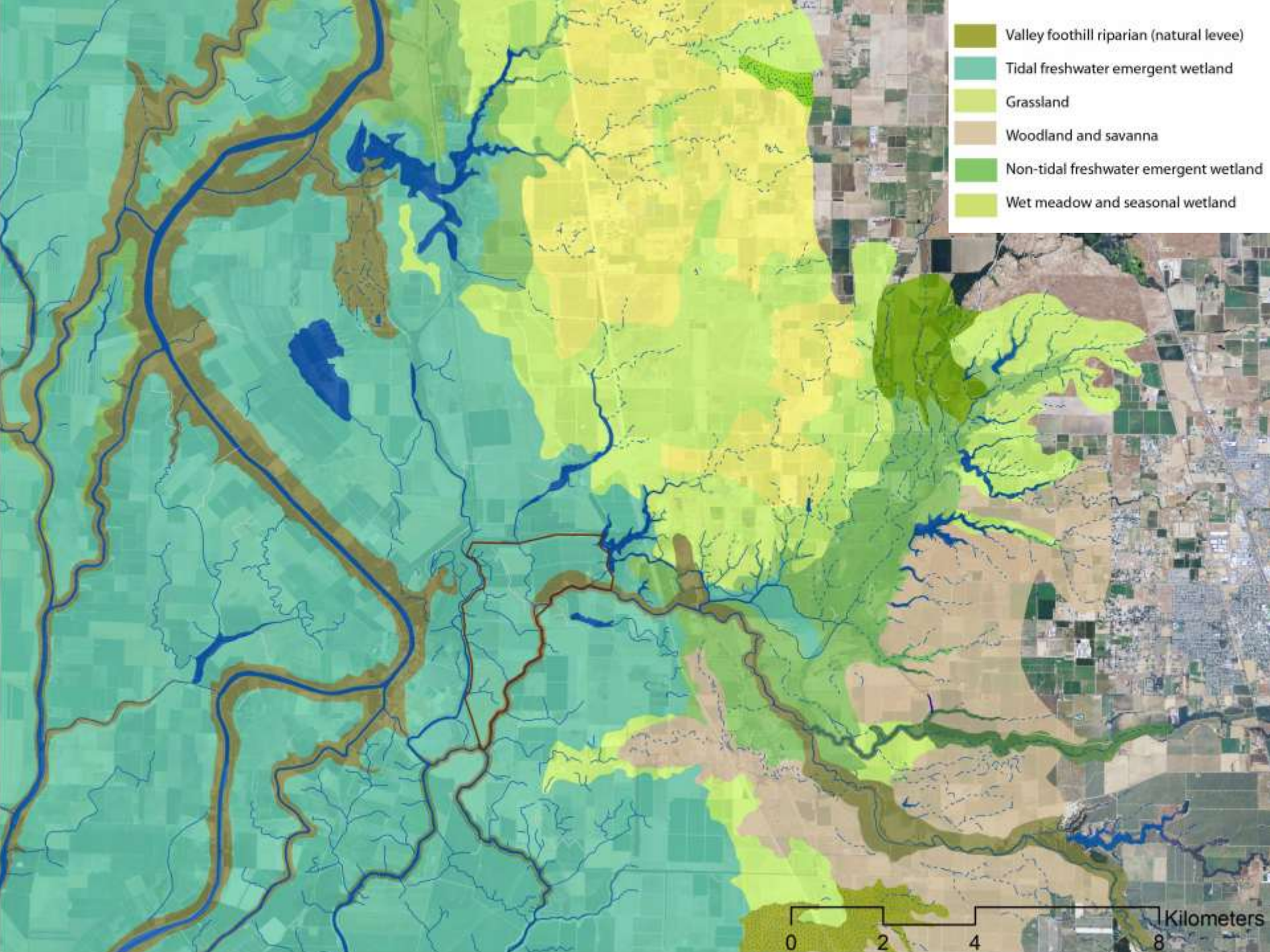
Case study: McCormack-Williamson Tract

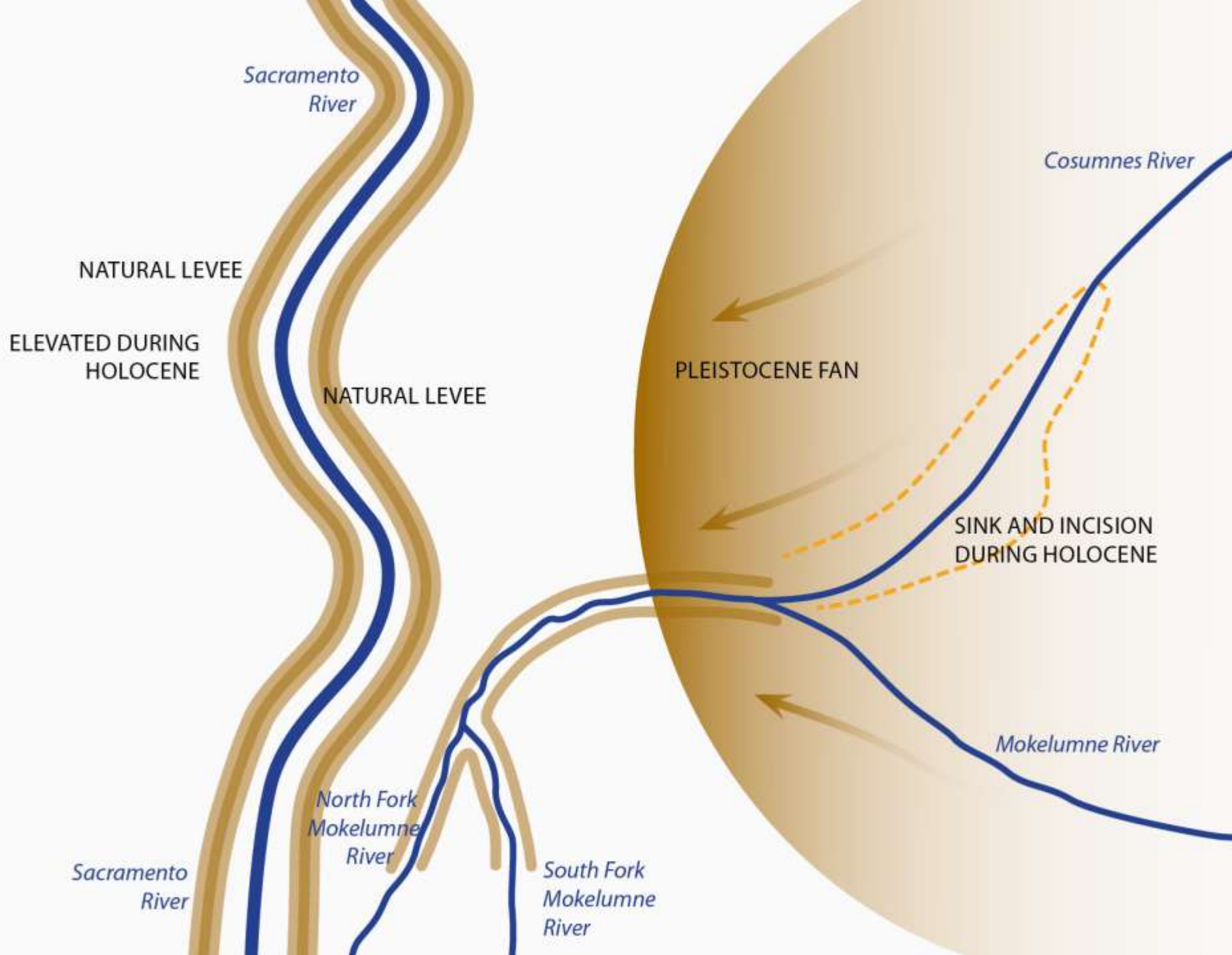
Opportunities

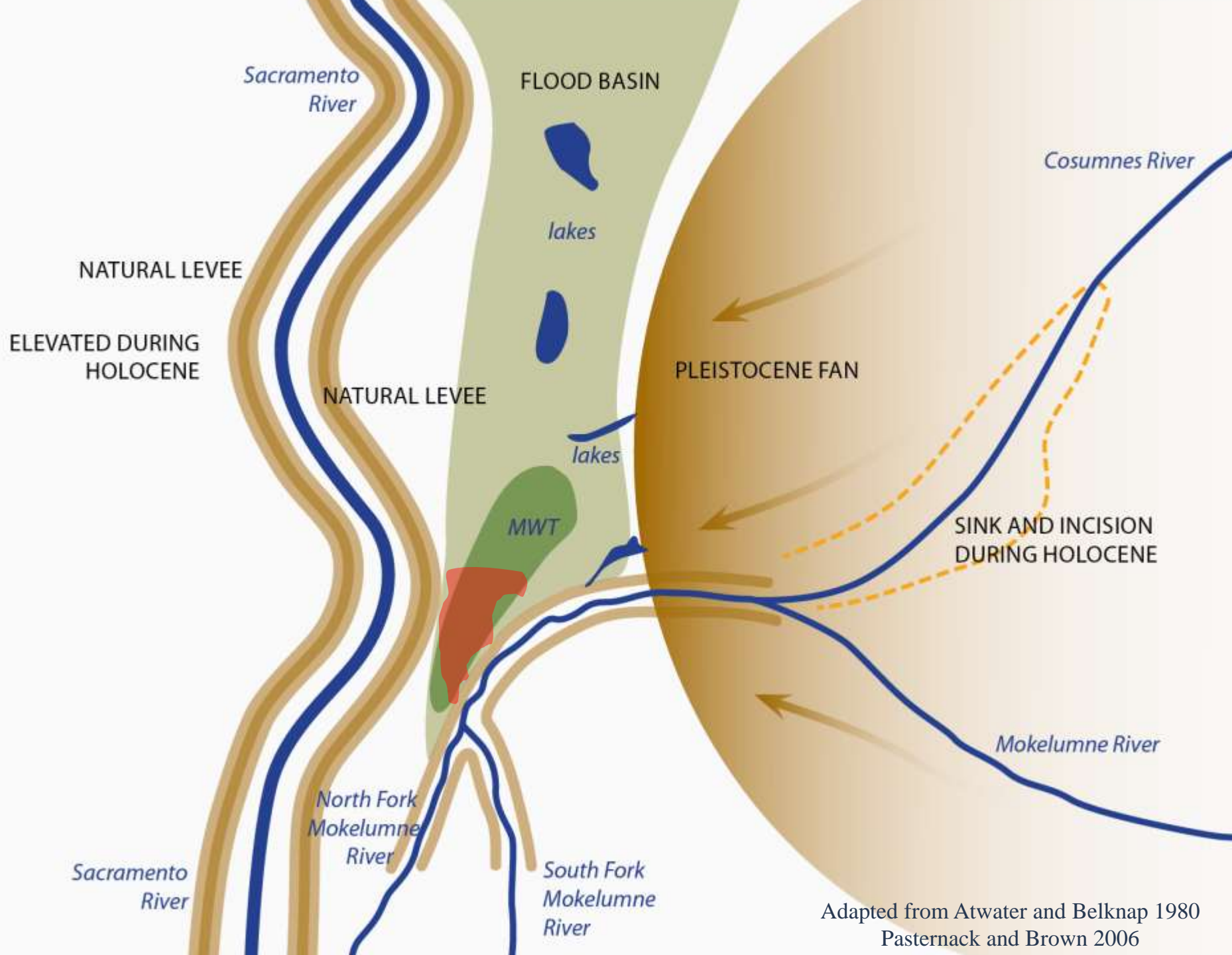
- Large restoration opportunity
- Variable topography
- Connection to uplands and tides
- Remnant historical features



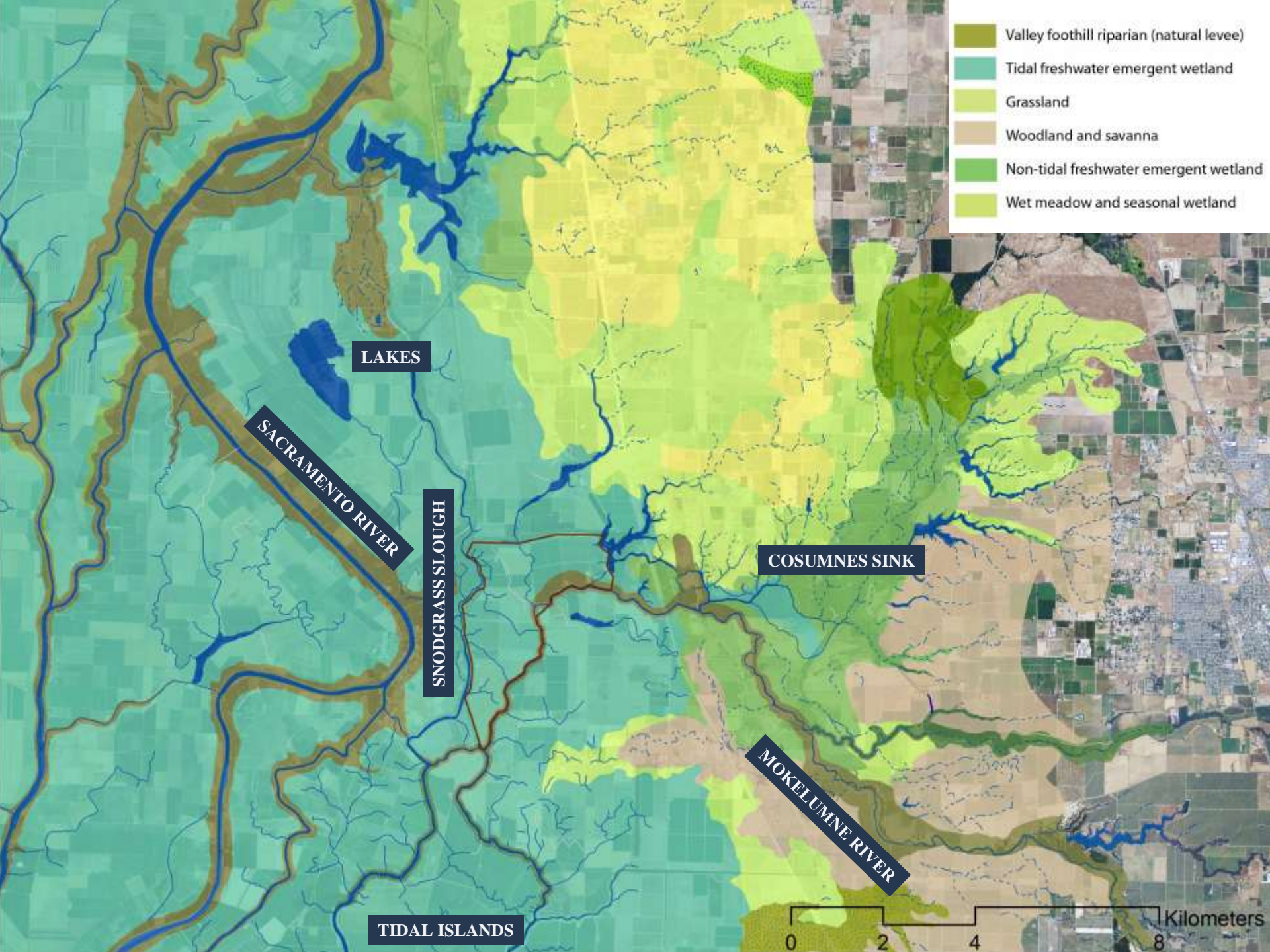




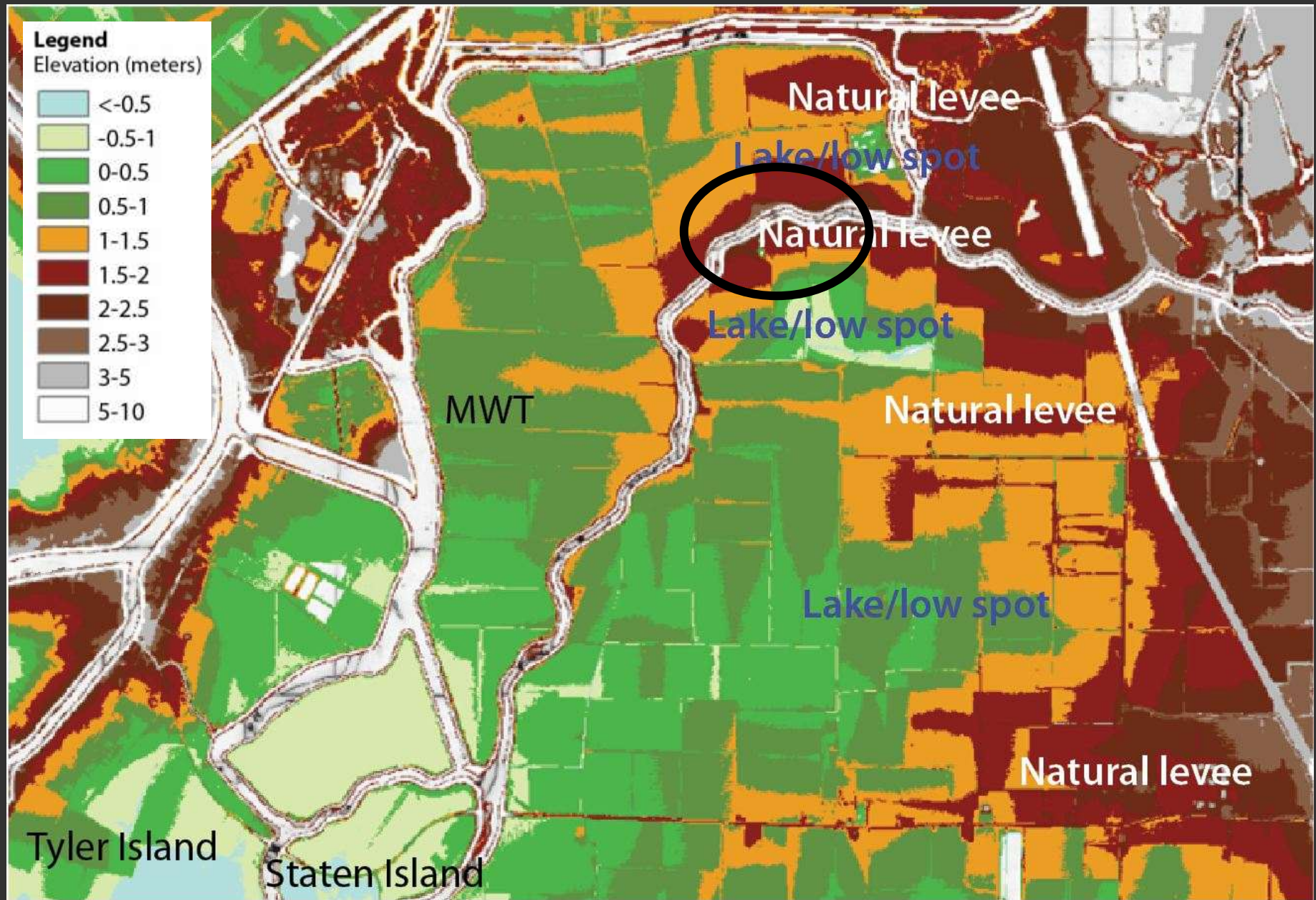


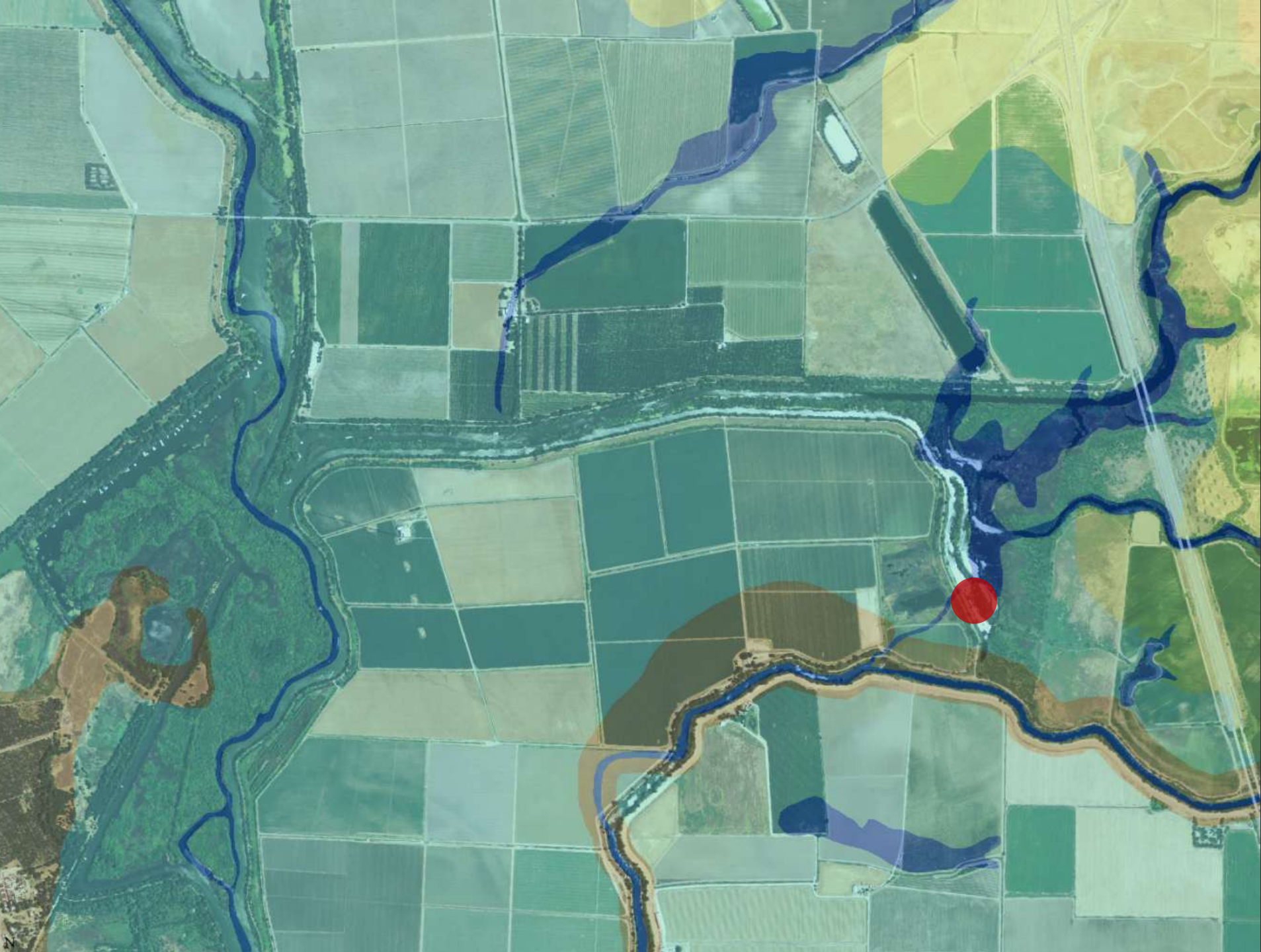


Adapted from Atwater and Belknap 1980
Pasternack and Brown 2006



Topographic Variability

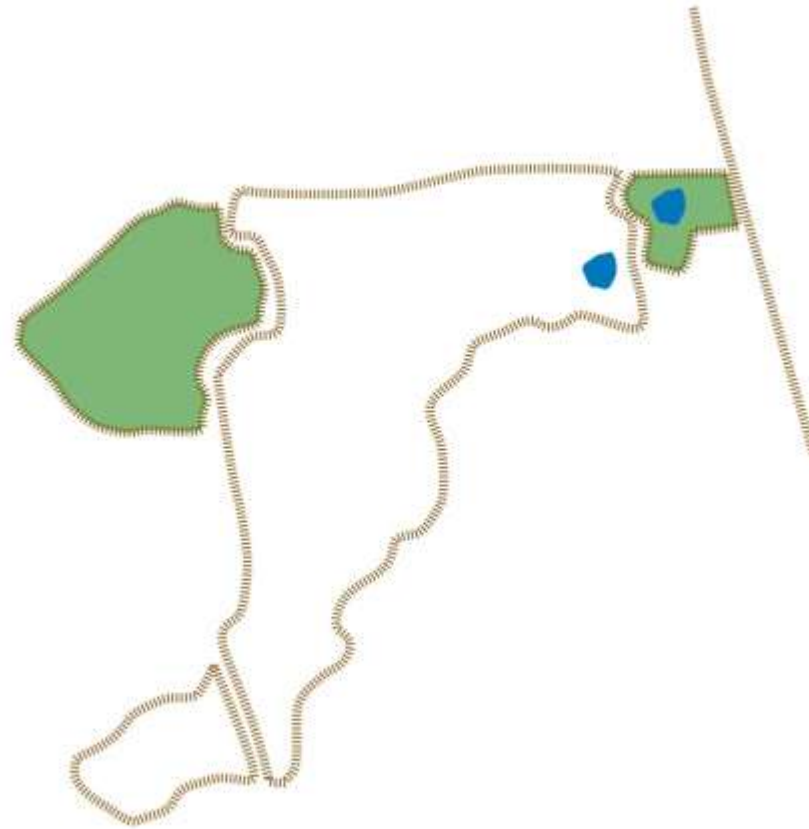




2050



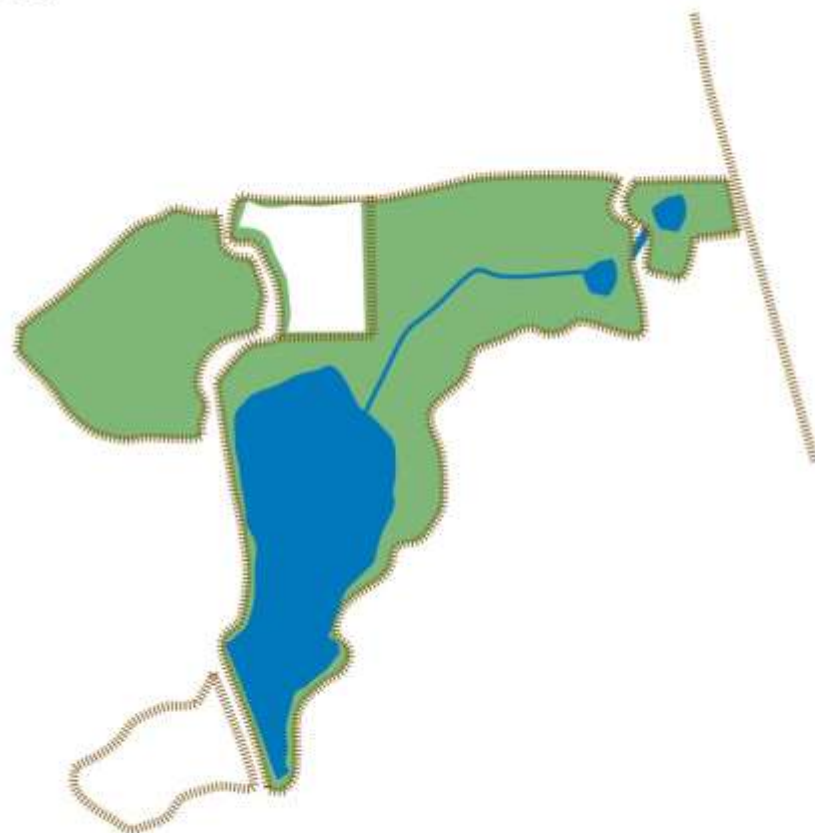
2012



2025



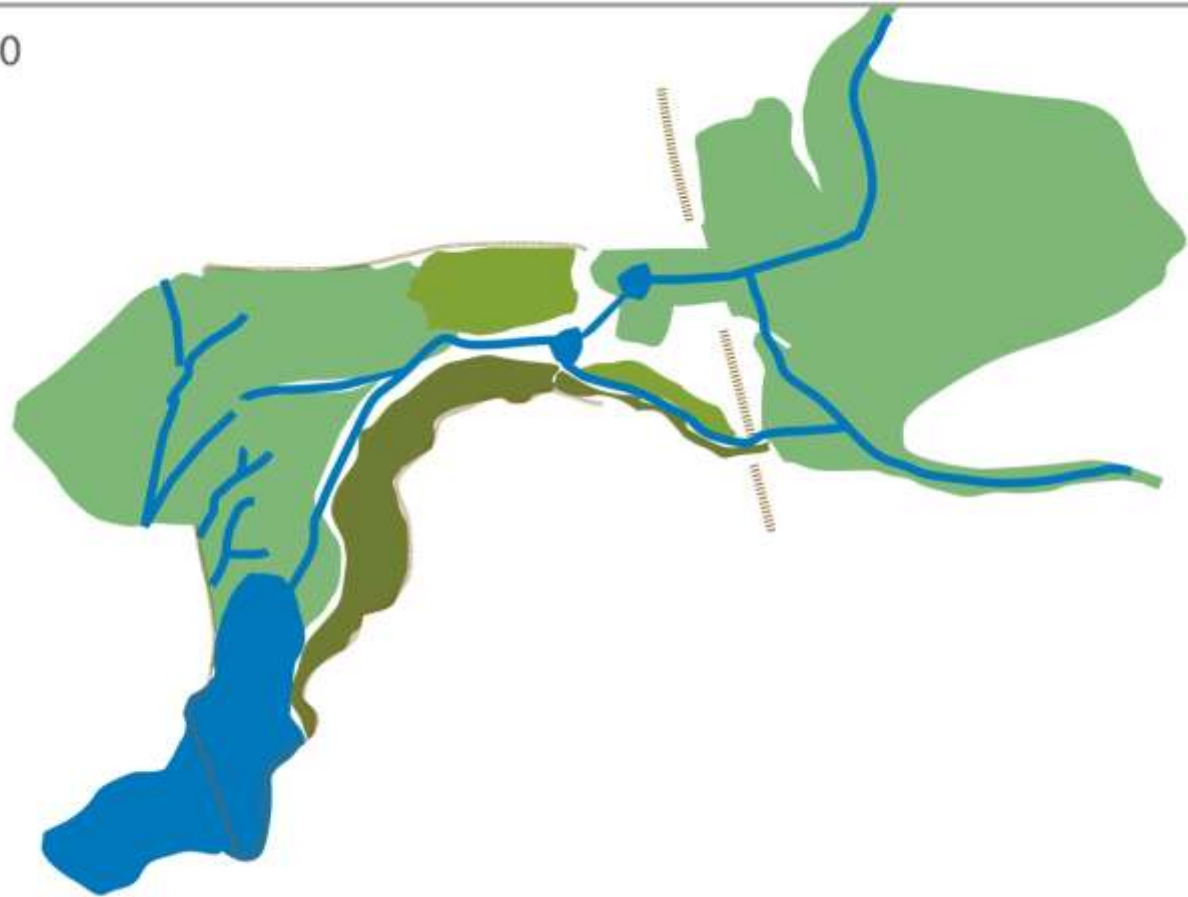
2100



2050



2100



is not what the landscape looked like in 1850.

Functional, resilient Delta landscapes could be re-established to support native species

- Can achieve higher function without restoring the past
- Physical gradients still remain: manage and plan with current and future expected physical gradients in mind
- Large and interconnected habitats may mean different things for different places (*functional landscape units*)
- Think at the large scale and in the long term
- The future will be different from both the present and the past, but emphasizing certain patterns and processes over others may yield a healthier ecosystem
- Restoration of individual parcels needs to add up to landscapes that fit into a vision for the whole Delta

THANKS

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Micha Salomon
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Chuck Striplen

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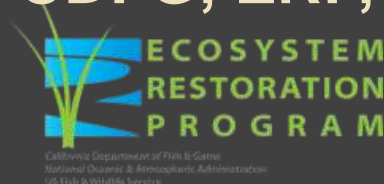
Carie Battistone
Daniel Burmester
Bronwyn Hogan

Gena Lasko
Amy Lyons
Daniel Rankin

Ciprian Simon
Carl Wilcox
Dave Zezulak

**Cliff Dahm, Anke Mueller-Solger, Chris Enright
Leo Winternitz
The LIT**

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THANK YOU

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